SCIENTIFIC AMERICAN SUPPLEMENT No. 58

Scientific American Supplement, Vol. III, No. 58.
Scientific American, established 1845.

NEW-YORK, FEBRUARY 10, 1877.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

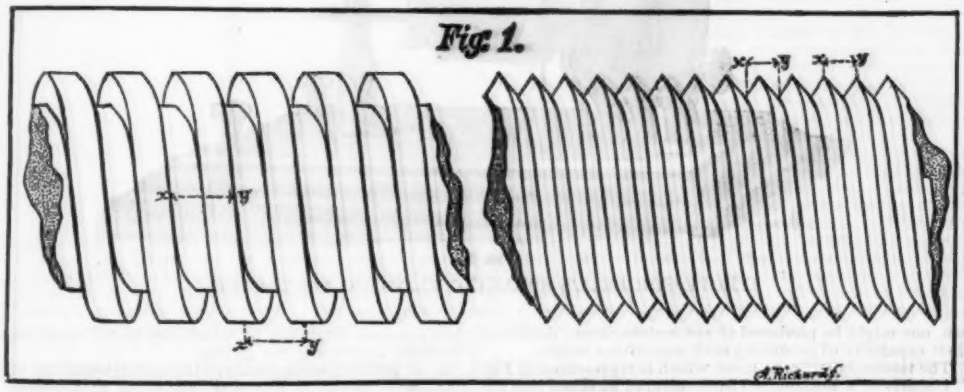
ON THE MINUTE MEASUREMENTS OF MODERN SCIENCE.

By Alfred M. Mayer.

Article II.

On the Micrometer Screw; its Scientific and Practical Applications.

The micrometer screw, as its name indicates, is a screw used in making minute measurements; for *micrometer* comes from two Greek words, *micros*, small, and *metron*, a measure; in other words, a micrometer (of any kind) is a measurer of the minute, and a micrometer screw is a screw which measures minute magnitudes. The principle of the action of the micrometer screw rests on the fact that when a screw is rotated one whole turn, it moves forwards or backwards in its block, or nut, through a definite length; which length is equal to the distance between the centers of two adjoining threads; or, what amounts to the same thing, the screw on being turned through one whole revolution progresses in its block through a distance which is equal to that separating two similarly placed points on two adjoining threads. This distance, which is called *the pitch* of the screw, is shown in the above drawings of a triangular and of a square threaded screw, by the length from *x* to *y*.



THE MICROMETER SCREW. ITS SCIENTIFIC AND PRACTICAL APPLICATIONS.

That one whole revolution given to a screw always causes it to progress in its block by the distance called the pitch, may be made evident to the reader by the following operation: Scratch a line across the threads of the screw in the direction of its length, then take a pointer and starting from the point where the line crosses a thread, follow the thread around the screw until the pointer again meets the scratched line. You will thus have followed the thread exactly one turn around the screw, and at the same time will have advanced the pointer in the direction of the screw, through a distance equal to that separating the centers of two adjoining threads. Now in one revolution of the screw, a point on its thread goes in the block through exactly the motion we made above with the pointer, and hence one revolution moves the screw in the direction of its length through the distance separating similarly placed points on two adjoining threads.

Figure 2 represents the micrometer screw in its simplest form. The screw *S* revolves in the block *N*, which is partly drawn in section so as to show the screw throughout its whole length. One end, P, of the screw terminates in a cylinder, with a slightly-rounded end surface. Opposite the end, P, is another similarly rounded surface, A, called the abutting point of the apparatus. To the other end of the screw is firmly attached a drum, D. The drum and screw are rotated by turning the milled head, M. The drum is divided into any number, say 100 equal parts, by lines drawn parallel to the length of the screw. These lines are numbered. An index, I, formed of a straight edge, is firmly fastened to the block, N. This index is divided into equal parts, each part being equal in length to the pitch of the screw. The edge of the index also serves to show the fraction of a revolution of the drum.

Let us now proceed to use this micrometer screw. For simplicity we will suppose that the pitch of the screw is equal to $\frac{1}{100}$th of an inch, that is to say, the screw has 100 threads to the inch. Hence one revolution of the drum will cause the end face, P, of the screw to move forwards or backwards through $\frac{1}{100}$th of an inch; one half revolution of the drum will progress the screw the $\frac{1}{200}$th of an inch, $\frac{1}{10}$th of a revolution will equal $\frac{1}{1000}$th of an inch. As the drum of the screw is divided into 100 equal parts, it follows that a rotation of the drum through one of these parts moves the end face of the screw only the $\frac{1}{10000}$th of an inch.

To apply the screw to an actual measurement, let it be required to measure the thickness of a plate of metal. The plate is set upright with one of its surfaces against the abutting point, A, and by rotating the screw its end, P, is brought against the other surface of the plate. The thickness of the plate is now evidently embraced between the end of the screw and the abutting point; and the screw from its construction gives us the means of ascertaining this thickness. The reading of the number of the revolution of the screw is now taken from the scale on the edge of the index, I, and the fraction of the revolution is read on the drum where the edge of the index cuts across it. The plate is now removed from the instrument, and the screw is revolved until the surface, P, of the end of the screw touches the face, A, of the abutting piece. Then another reading is made on the index scale, I, and on the drum, D. The difference between these two readings gives the number of revolutions, and the fraction of a revolution required to give the screw in order to progress its face, P, through the distance equal to the thickness of the plate; and the $\frac{1}{100}$th of an inch multiplied by the above number of revolutions and fraction of a revolution gives the thickness of the plate, in inch measure, down to the $\frac{1}{10000}$th part of an inch, *provided that* certain conditions in the instrument, necessary to reach that degree of precision, existed during our measurement.

The essential conditions that must exist in a micrometer screw, in order that it may serve in measuring to a minute degree of precision, may be reduced to *three.*

(1.) The first condition is that the pitch of the screw should be known to the last degree of precision. The manner of determining the pitch of a screw I will explain in a subsequent article.

(2.) The second essential condition is that during the measurement the parts of the instrument shall experience no change of form, or of relative position, from the action of flexure or of compression, produced by the screw running against the abutting point or object. Also, no change must occur in the parts of the apparatus from a change of temperature during the measurement.

(3.) The third condition necessary to attain accuracy is that the *contact* of the screw with the abutting point and with the surface of the object to be measured shall be made always with the same degree of pressure, and yet with so slight a pressure that no strains or compression can thus be caused in the apparatus.

The fulfillment of the third condition of accuracy reduces to a very minute quantity the errors caused by flexure and compression. Hence, as we may always readily command a constant temperature during the measurement, it will only be necessary, at present, to show how we obtain the third condition necessary to accurate work with the micrometer screw.

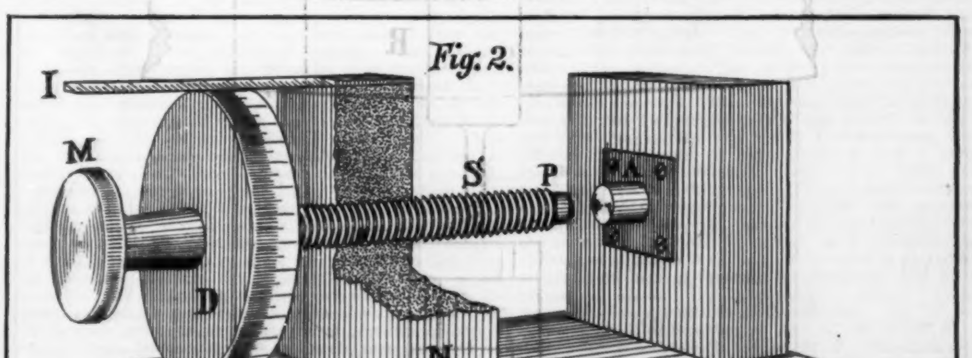
Three methods have been devised for making contacts, so that the point of the screw shall always touch the abutting point, or the body between the abutting point and the screw, with a pressure which is light yet always the same in degree.

The first method of making contact we shall denominate as that of (1) *the contact lever;* the second is known as that of (2) *the contact level;* the third we may call (3) *the method of electric contact.*

Before beginning the description of these methods, I should state that the drawings which we give in this article are mostly diagramatic, and have been made more in the view of being clear to the reader in illustrating the mode of action of the instruments, than to show the details of their construction and the proportions of their parts. In subsequent articles engravings will be given which actually represent existing instruments. We here, in Figure 3, give an engraving of an actual micrometer screw, similar in its action to the diagramatic one just described. This instrument is made by the Brown & Sharp Manufacturing Co., of Providence, R. I., and from actual use with it I know that it can be relied on to measure down to the thousandth of an inch. This screw has a pitch of $\frac{1}{40}$th of an inch, and its head, D, is divided into 25 parts; hence one revolution of the head equals $\frac{1}{40}$th or .025 of an inch; and an amount of rotation equal to one division of the head progresses the screw in its nut the $\frac{1}{1000}$th of an inch. The scale of revolutions of the screw is shown at *a*.

(1.) *The Contact Lever.*—Fig. 4 shows a contact lever fitted to a micrometer screw; in this manner: The screw is cut on the surface of a hollow cylinder. In the interior of this hollow screw fits, with great nicety, a rod of steel, *a*, whose point, *p*, is seen projecting beyond the screw. The lower portion of the screw is shown in section to exhibit its central steel core. On the upper portion of this central rod is a collar which rests on the top of the screw head, *d*. Against the upper end of the rod presses a lever, *l*, which in its turn is pressed by the second lever, *n*, the latter being acted on by the delicate spring, *e*. The free end of the second lever, in its revolution around its fulcrum, runs over a graduated arc, *c*. The use of the arrangement is readily understood. In making a measurement the screw is revolved downwards by its head, *d*, until the point of the central steel rod touches the abutting point, or the surface of the body to be measured. The screw on being turned further, causes the rod, *a*, to move upwards through the screw, and this upward motion of the rod is produced till the index of the second lever points to *o* on the graduated arc, *c*. Thus the point of the screw—which is in fact the point of its central rod—always touches an object with a delicate pressure, and, what is more important, always touches with the *same* pressure. In the figure we have shown the screw applied to the measurements of the deflections of a rod, R. More and more weight is placed on W, and after each additional weight the increased deflection is followed by the screw till the delicate lever, *n*, points to *o* of the graduated arc. Then the reading is made on the index, *i*, whose scale gives the number of the revolution last made by the screw, and this number is written before the reading on the drum head, which gives the fraction of the revolution of the screw. By such experiments can be made exceedingly accurate investigations as to the deflections produced in bars of known section by given weights; and the laws ruling such strains can be discovered for the practical use of those who employ in construction the materials experimented on.

To convey a clear idea of the degree of accuracy of a micrometer screw when furnished with a contact lever, I here give twelve measurements, in fractions of an inch, on the thickness of a glass plate. These measurements I have just made; and I give all of those I made, and exactly in the order in which they were executed. The instrument used was a contact-lever micrometer screw, made by Brünner of Paris.

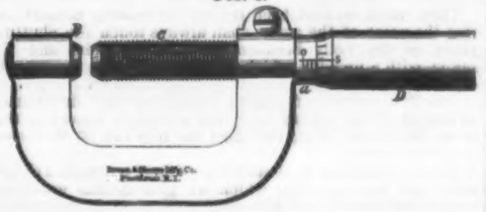


THE MICROMETER SCREW. ITS SCIENTIFIC AND PRACTICAL APPLICATIONS.

No. of Measure.	Measurement.	Differences.
1.	0 inch .219368	+ .0000035 inch.
2.	.219360 = minimum	— .0000045
3.	.219368	+ .0000035
4.	.219368	+ .0000035
5.	.219364	— .0000005
6.	.219360 = minimum	— .0000045
7.	.219373 = maximum	+ .0000085
8.	.219368	+ .0000035
9.	.219368	+ .0000035
10.	.219364	— .0000005
11.	.219373 = maximum	+ .0000085
12.	.219360 = minimum	— .0000045
	0 in. .2193645 = mean.	

The reader, on examining these measurements, will observe that they all agree in the fourth decimal place, that is, to $\frac{1}{10000}$th of an inch. Differences in the successive measure-

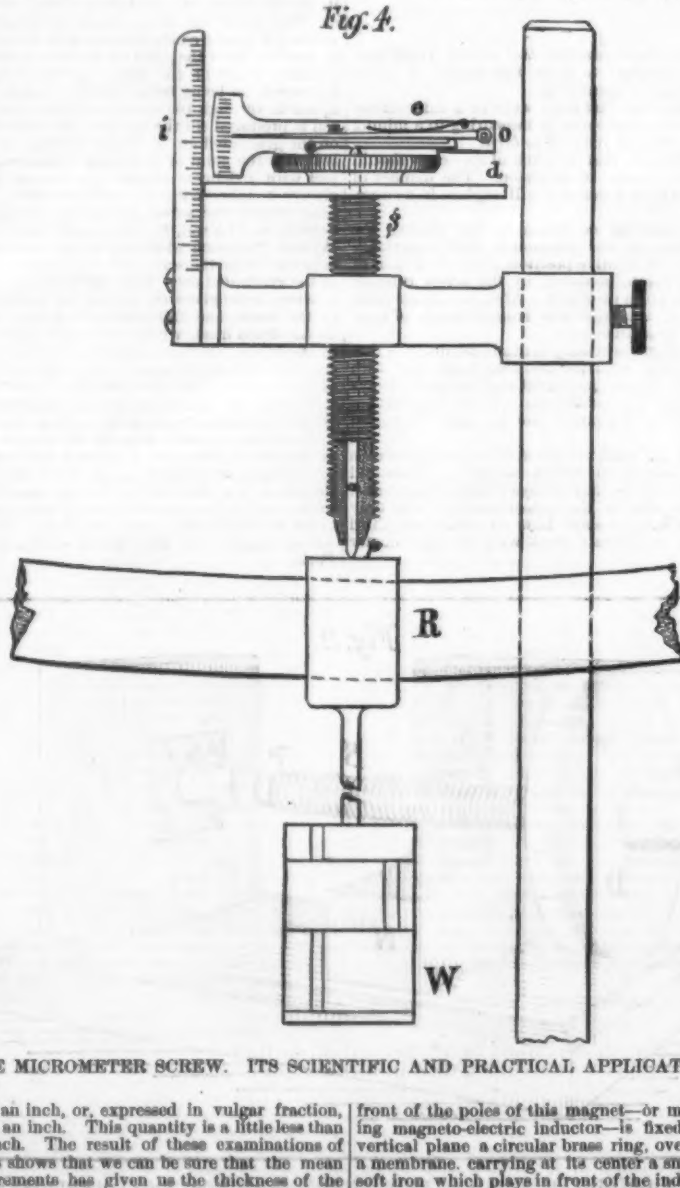
FIG. 3.



ments only occur in $\frac{1}{100000}$ths of inches. The greatest difference existing is between the 2d, 6th, and 12th, which measures are .219360, and the 7th and 11th, which are .219373. The difference between these extreme measure is .219373 — .219360 = .000013, or $\frac{13}{1000000}$ths of an inch; which fraction is nearly equal to $\frac{1}{77000}$th of an inch. But the latter fraction represents the extreme range of error in our measurements. Evidently the minimum measurement or the maximum is nearer the true measure than the $\frac{1}{77000}$th of an inch, and the *mean* of the extreme measures is yet nearer than either of them. But in measurements of precision we always take for our final result the mean of a number of measures This mean is obtained by adding up all the separate measures, and then dividing this sum by the number of the separate measures. This we have done for our twelve measures, and find the mean to be .2193645. If we assume this number to be the real thickness of the plate, and then subtract it from the separate measures, we will obtain numbers either above (+) or below (—) this mean number, and these *differences* between the mean number and each separate measurement will give the reader an idea of the error made in each successive measure. In the above table the third column of figures gives the differences. An examination of this table of differences shows that the greatest difference existing between the mean of all of the measures and any separate measure, is the .0000085 of an inch, or, expressed in vulgar fraction, the $\frac{85}{10000000}$th of an inch. This quantity is a little less than $\frac{1}{100000}$th of an inch. The result of these examinations of our measurements shows that we can be sure that the mean of all the measurements has given us the thickness of the plate to within the $\frac{1}{100000}$th of an inch; and this marvellous accuracy of our measurements is due to the aid of the contact lever; for without this appliance we could not have relied on the measures by the screw to a quantity less than the $\frac{1}{50000}$th of an inch.

The reader should here understand that the above are not *selected* measures. I made them without any practice immediately preceding the measurements. I ceased writing this article, rose from the table, took the instrument from the case, and at once made the twelve measures given above. I then requested one of the students in my laboratory to make a series of measurements, while he remained ignorant of my results. Then an officer of the U. S. Coast Survey, a gentleman practiced in minute measurements, who had just entered my laboratory, made another series. These gentlemen made the same range of error as I had previously attained; but we all came to the conclusion that if we had practised some time with the instrument immediately before beginning our series of measurements, we should have brought the range of error to within the $\frac{1}{100000}$th of an inch.

Fig. 4.



THE MICROMETER SCREW. ITS SCIENTIFIC AND PRACTICAL APPLICATIONS.

THE SPEAKING ELECTRIC TELEGRAPH.

THE articulating telephone of Mr. Graham Bell, like those of Reis and Gray, consists of two parts, a transmitting instrument and a receiver, and one cannot but be struck at the extreme simplicity of both instruments, so simple indeed that were it not for the high authority of Sir William Thomson, one might be pardoned at entertaining some doubts of their capability of producing such marvellous results.

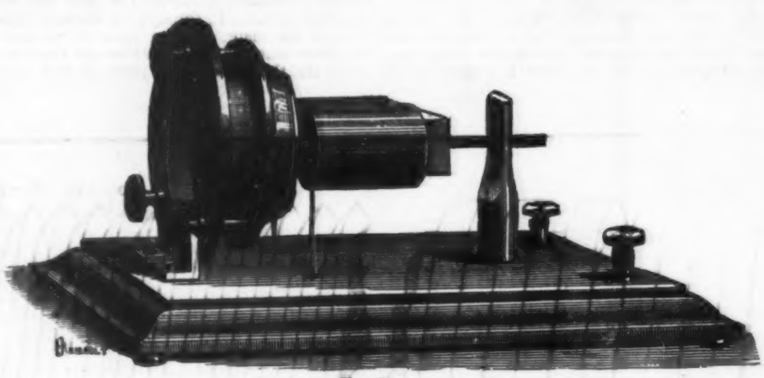


FIG. 1.

PROFESSOR BELL'S SPEAKING ELECTRIC TELEGRAPH.

The transmitting instrument, which is represented in Fig. 1, consists of a horizontal electro-magnet attached to a pillar about 3 inches above a horizontal mahogany stand: in front of the poles of this magnet—or more correctly speaking magneto-electric inductor—is fixed to the stand in a vertical plane a circular brass ring, over which is stretched a membrane, carrying at its center a small oblong piece of soft iron which plays in front of the inductor magnet whenever the membrane is in a state of vibration. This membrane can be tightened like a drum by the three mill-headed screws shown in the drawing. The ends of the coil surrounding the magnet terminate in two binding screws by which the instrument is put in circuit with the receiving instrument, which is shown in Fig. 2. This instrument is nothing more than one of the tubular electro-magnets invented by M. Nicles in the year 1852, but which has been re-invented under various fancy names several times since. It consists of a vertical bar electro-magnet enclosed in a tube of soft iron, by which its magnetic field is condensed and its attractive power within that area increased. Over this is fixed, attached by a screw at a point near its circumference, a thin sheet iron armature of the thickness of a sheet of cartridge paper, and this when under the influence of the transmitted currents acts partly as a vibrator and partly as a resonator. The magnet with its armature is mounted upon a little bridge which is attached to a mahogany stand similar to that of the transmitting instrument.

The action of the apparatus is as follows: When a note or a word is sounded into the mouthpiece of the transmitter, its membrane vibrates in unison with the sound, and in doing so carries the soft iron inductor attached to it backwards and forwards in presence of the electro-magnet inducing a series of magneto-electric currents in its surrounding helix, which are transmitted by the conducting wire to the receiving instrument, and a corresponding vibration is therefore set up in the thin iron armature sufficient to produce sonorous vibrations by which articulated words can be distinctly and clearly recognized.

In all previous attempts at producing this result, the vibrations were produced by a make-and-break arrangement, so that while the number of vibrations per second as well as the time measures were correctly transmitted, there was no variation in the strength of the current, whereby the quality of tone was also recorded. This defect did not prevent the transmission of pure musical notes, nor even the discord produced by a mixture of them, but the complicated variations of tone, of quality, and of modulation which make up the human voice, required something more than a mere isochronism of vibratory impulses.

In Mr. Bell's apparatus not only are the vibrations in the receiving instrument isochronous with those of the transmitting membrane, but they are at the same time similar in quality to the sound producing them, for the currents being induced by an inductor vibrating with the voice, differences of amplitude of vibrations cause differences in strength of the impulses, and the articulate sound as of a person speaking is produced at the other end.

Of the capabilities of this very beautiful invention we cannot give them better than in the words of an ear-witness, and no less an authority than Sir William Thomson, who, in his opening address to Section A at the British Association at Glasgow, thus referred to it:

"In the Canadian Department I heard 'To be or not to be........there's the rub,' through an electric telegraph

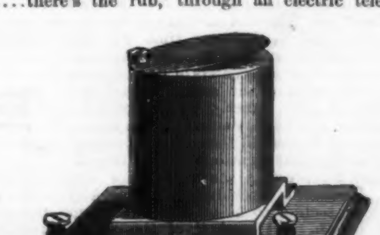


FIG. 2.

wire; but scorning monosyllables, the electric articulation rose to higher flights, and gave me passages taken at random from the New York newspapers: 'S. S. Cox has arrived' (I failed to make out the 'S. S. Cox'); 'the City of New York;' 'Senator Morton;' 'the Senate has resolved to print a thousand extra copies;' 'the Americans in London have resolved to celebrate the coming 4th of July.' All this my own ears heard, spoken to me with unmistakable distinctness by the then circular disk armature of just such another little electro-magnet as this which I hold in my hand. The words were shouted with a clear and loud voice by my colleague judge, Professor Watson, at the far end of the telegraph wire, holding his mouth close to a stretched membrane, such as you see before you here, carrying a little piece of soft iron, which was thus made to perform in the neighborhood of an electro-magnet, in circuit with the line, motions proportional to the sonorific motions of the air. This, the greatest by far of all the marvels of the electric telegraph is due to Mr. Graham Bell, of Edinburgh, and Montreal, and Boston, now becoming a naturalized citizen of the United States. Who can but admire the hardihood of invention which devised such very slight means to realize the mathematical conception that, if electricity is to convey all the delicacies of quality which distinguish articulate speech, the strength of its current must vary continuously and as nearly as may be in simple proportion to the velocity of a particle of air engaged in constituting the sound."—*Engineering.*

ELECTRIC MOTOR PENDULUM.

THE following very simple apparatus may, I think, be of use in any laboratory or other place where at times it is necessary to have a pendulum beating seconds in order to give the time for any experiments needing it.

It consists of a Siemens' galvanoscope, A, to which is attached the pendulum; the needle N, preferably with platinum contacts, works between two platinum wires, B and C, with a small amount of play; these platinum wires are insulated from one another by being fastened into a piece of ebonite, which works on a pivot D. The needle is connected by its support to one end of the coil of the galvanoscope, the other end being to earth. To the wires, B and C, are connected the opposite poles of a small battery, the center of the battery being to earth.

The action of the instrument is as follows: On slightly oscillating the pendulum, the needle N makes contact between B say, and the coil, the magnet being so arranged that the needle then deflects towards B, thus carrying with it the movable contact wires until the pendulum reaches its limit of oscillation, when it falls, breaks contact with B and makes

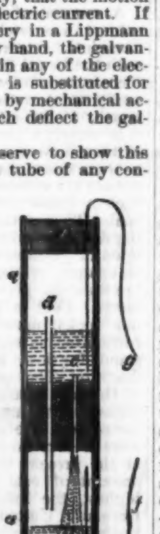
contact with C, which thus tends to pull the needle over to C, and so on; in this way the pendulum receives at each oscillation the impulse necessary to overcome the forces tending to stop it; and thus will keep oscillating as long as the battery supplies the motive power. For small arcs the beat is *not affected by variation in battery power*.

In the circuit of the battery we can introduce an electromagnet which at each contact of the pendulum on one side will make a stroke on a bell, or indeed by a detent will move by a small train of wheels the hands of a clock. If the pendulum is made to beat half seconds, then the contact being made alternately on each side, the bell stroke would beat seconds. We could of course introduce any number of arrangements of this sort at any intervals along the circuit, and so move any number of clocks at different positions in a large establishment, only one pendulum being requisite to control the whole set.—P. HIGGS.—*Nature*.

ELECTRO-CAPILLARY PHENOMENA.

THE electro-capillary machine of Lippmann and his capillary electrometer, besides the capillary electroscope of Werner Siemens and the electro-chemical relay of Wheatstone, are all illustrations of a phenomenon resulting from *application* of an electric current. I am not aware that the converse phenomenon is so generally known, namely, that the motion of the mercury in the tube *produces* an electric current. If we substitute a galvanometer for the battery in a Lippmann capillary machine, and move the lever by hand, the galvanometer needle is deflected. Similarly, if in any of the electro-capillary electrometers a galvanometer is substituted for the battery and the bubble caused to move by mechanical action, electrical currents are produced which deflect the galvanometer needle.

The following small instrument may serve to show this action for lecture purposes: *a a* is a glass tube of any convenient bore, say 15 to 20 millimetres, by 300 mm. length; *b* is a cork fitting tightly into the middle of the tube, and perforated in two places where are inserted—at *c* a tube of ½ mm. bore, slightly longer than the cork is thick, and at *d* a longer tube, extending half way into both compartments. The ends of the tube *a a* are stopped by the corks *e e*, through which pass the platinum wires *f g*. Sufficient mercury to quarter fill each compartment is introduced into the tube *a a*, with a small quantity of diluted sulphuric acid. The apparatus being now sealed up, the wires *f* and *g* are connected to the terminals of a somewhat delicate galvanometer.



By inverting the tube, as is done with an hour or egg glass, a current flows through the galvanometer so long as any mercury runs through the tube *c* (the tube *d* is an air tube simply). Reinverting the tube gives a current in an opposite direction, the platinum wire from that compartment from which the mercury flows always being the zincode of the electrical system. The current decreases with the mercury in the upper chamber as it falls, being a maximum with greatest head of mercury, and falling to nothing when all the mercury has dropped through. By any arrangement maintaining a constant head of mercury a constant current may be maintained.

Such an apparatus is especially useful in an electrical laboratory where weak currents are required for the adjustment of delicate galvanometers, or where the heating effect of currents of greater intensity and quantity are required to be avoided. The apparatus can be made in glass and hermetically sealed. A tube like the above placed on a stand which will allow it to revolve in a vertical plane, and fitted with a commutator, can be made to give a constant current in one direction, and is always ready to hand.

With a filter funnel, the tube of which is drawn out to a fine point placed above a vessel containing mercury and acidulated water (wires being led from the funnel and lower vessel to the galvanometer, some interesting results are to be noticed which serve to throw considerable light on the action in electro-capillary apparatus. It will be found that when the mercury breaks away from the funnel at too great height the mercurial column becomes discontinuous, the circuit is interrupted, and of course no current passes through the galvanometer; and when the funnel is brought so close to the lower vessel as to give only a continuous column, the current is on short circuit and the galvanometer needle undeflected. There is a point, consequently, between these two positions giving a maximum current in the outer circuit, and this is easily found experimentally.—P. HIGGS.—*Nature*.

NEW DRY ELECTRIC PILE.

By CHARLES LOUIS VAN TENAC, Paris, France.

MY new pile consists in an outer shell in chloride of silver, within which I place a coil of zinc wire, or a perforated sheet of zinc, reserving a certain space between these two elements, which I fill with blotting-paper, sawdust, sand, or other absorbent material. For the purpose of better insulation, I cover this outer shell with one or two rounds of paper, preferably pasted thereto, and over the paper I pass a tube of soft rubber or other insulating material. I close the two ends with hard-rubber covers, or other hard insulating material, in one of which I make a small opening, which I close hermetically by means of a plug, and through the other I pass two small wires, one of which is the continuation of an undulated silver or platinum wire, incorporated in the chloride of silver shell, in which it is wound from bottom to top, and the other constitutes the upper extremity of a similar wire, which runs up from the bottom of the zinc element, in contact with each individual coil of which the latter is composed. Both protrude to a certain distance outside the hard-rubber cover, and are, when required, connected together by a small sliding mechanism attached to the cover aforesaid, and as hereafter described.

The exciting liquid which I make use of is chloride of zinc at from five to ten per cent., or a saturated solution of marine salt. For the purpose of charging my pile, after having withdrawn the plug aforesaid, I fill the battery therewith, allowing it to remain therein until the absorbing material aforementioned has been entirely saturated, and then pour out all the remaining liquid and re-insert the plug.

My new pile can be made of any shape or size within reasonable limits; however, in order to produce an available practical result, the inner surface of the chloride of silver case should not be less than six square inches, and of that size it is capable of reddening a platinum coil for industrial or other purposes. As it is only brought into action when the circuit is closed, it is of very long duration in consequence of such intermittent action. For instance, it can be made available thirty thousand times, and even more, for producing a light, as it is hereafter explained, without its being necessary to recharge it with the exciting liquid.

I reserve a central space or chamber within the zinc coil, for the purpose of receiving or housing the gases formed by the chemical decompositions of the elements of the pile, allowing such to combine in order to react on the elements, thus insuring a long period of duration of the pile, and a greater power. By placing the chloride externally and the zinc internally, contrary to previous practice, I obtain a relatively much larger surface of chloride than of zinc, whereby I obtain, in a relatively very small volume, the same power as actually obtained with piles of a considerably larger volume. Again, these piles, being perfectly hermetic and dry, are available for being carried in the pocket, and for producing flame by contact with a wick saturated with an inflammable liquid, or fire by contact with a dry fibrous wick.

GRAVITATION AND ELECTRIC ACTION.

M. A. PICART.

ALL the phenomena of the universe may be explained by matter and motion *alone* without *forces acting at a distance*. For this purpose it is sufficient to imagine infinite space filled with eternal matter consisting of a mass of atoms animated by a perpetual movement in all directions. This matter, the sub-stratum of the world, is what is commonly called *ether*. Only it has been hitherto regarded as a fluid whose molecules have in a state of equilibrium fixed relative positions, each exerting upon the neighboring molecules a repulsive action which give rise to vibratory movements whenever this equilibrium is disturbed by any cause whatsoever. According to the new theory of gaseous fluids (Clausius) we may henceforth conceive the ether as formed of *elastic* atoms moving with considerable speed in all directions, and producing at each point by their impacts upon an ideal elemental plane a determined pressure. From this new conception of the ether, which in nowise contradicts the ancient view, and which even includes it as a corollary (*Theorie mécanique de la chaleur*, de M. Briot), gravitation at once follows, *i. e.*, the mutual attraction of two material points in the ratio of their masses, and inversely as the square of their distance. As to electric actions they may be explained in an analogous manner. The material molecules in arranging themselves by their mutual attractions so as to form bodies must condense around themselves the ethereal atoms as atmospheres more or less dense, the elasticity of which must vary according to the relative positions of the molecules of the body. These are the atmospheres whose increases or diminutions of density or of elastic force constitute the electric condition—positive or negative—of the body. Between these atmospheres and the material molecules situate at a distance there must be exerted a gravitation like that of two material molecules. Between two condensed atmospheres of ether a repulsive action must be exerted, resulting from the necessary increase of the speed of the atoms which move in both directions from the one atmosphere to the other, and which produce upon each of them, on the side where they strike, an augmentation of pressure tending to remove them from each other. From these reactions we easily arrive at Coulomb's law of attraction or repulsion; the basis of all electrical theory.—*Comptes Rendus*.

LABORATORY NOTES.

By T. A. EDISON.

1. HARD rubber or vulcanite, placed for several weeks in nitrobenzol, becomes soft and pliable like leather, and easily broken.

2. The vapor of chloral hydrate is a solvent of cellulose. I have found the corks of bottles containing the crystals eaten away to the depth of a quarter of an inch, the cork being resolved into a black semi-liquid. Certain kinds of tissue paper are partially dissolved in time, if thrown in a bottle containing the crystals.

3. A very difficult substance to dissolve is gum copal. I have found that aniline oil dissolves it with great facility.

4. Hyposulphate of soda is apparently soluble to a considerable extent in spirits of turpentine. Large crystals of "hypo" melt down to a liquid after several weeks, and, if the bottle be shaken, partially disappear. The turpentine smell nearly disappears.

5. The vapors of iodine, in the course of several months, will penetrate deeply into lumps of beeswax.

6. If to a solution of bisulphide of carbon there be added twice its bulk of potassic hydrate in sticks, and the bottle be well sealed, the whole will, in two months, become an intense reddish, sirupy liquid, with scarcely any free bisulphide of carbon.

7. Some substances in solution form crystals or deposits on the sides of the bottles containing them, generally above the water line. Among such solution in 100 c. c. of rain water may be mentioned a 14-gramme solution of acetate of uranium, 8-gramme do. of protoacetate of copper, 5-gramme do. of acetate of morphine, 10-gramme do. of formate of copper, 20-gramme do. of tannate of iron. These deposits invariably take place on that part of the bottle most *exposed to light*. This phenomenon may be due to heat, but deposits or films occur in some solutions *within the liquid* as well as above it—especially noticeable with tannate of iron, the film of which adheres strongly to glass.—*American Chemist*.

NEW METHOD OF SEPARATING NICKEL AND COBALT.

By ANTHONY GUYARD (HUGO TAMM).

THE alkaline sulphocyanides exert an unequal action on the sulphides of nickel and of cobalt recently precipitated. In the cold we do not observe a very marked action, but on raising the temperature we see the sulphide of nickel enter into solution with a very great facility, whilst the sulphide of cobalt resists more, and only dissolves even in a considerable excess of sulphocyanide, after prolonged boiling. This reaction is not sufficiently distinct for analytical application, but by a modification we render it practical, and find ourselves in possession of a very elegant and very exact method of separating nickel from cobalt. In fact, in *cold* and *very dilute* liquids, the sulphide of nickel recently precipitated is dissolved with a surprising rapidity in *cyanide of potassium*, whilst sulphide of cobalt is perfectly insoluble. In these conditions the reaction is so clear and distinct that we may find in the oxide of nickel traces of cobalt (which we could only detect by the aid of the blowpipe), and effect their separation.

In the course of an analysis the best way of proceeding is as follows:—We separate, in the usual manner, the cobalt and nickel from the metals which accompany them; then we precipitate both by a slight excess of sulphide of ammonium. We dilute the liquid with a suitable quantity of water; then add gradually a weak solution of cyanide of potassium, avoiding excess. This operation is rendered easy by the fact that the mass of sulphides clears up, and the sulphide of cobalt floats in particles detached from each other, and we distinctly see what passes in the liquid. We then filter, collect the sulphide of cobalt, and determine the cobalt in the ordinary way. To isolate the nickel we acidulate the filtered liquor with a slight excess of muriatic or sulphuric acid. The nickel is precipitated in the state of cyanide, and that so completely that we cannot find traces of it in the liquid. This cyanide is collected upon a filter, well washed, and then calcined. Oxide of nickel is thus obtained so pure, in some cases, that it may be weighed and determined at once as nickel. However, in general, it is prudent to purify this oxide, which often retains silica; in this case we proceed in the ordinary manner.

The advantage of the process which I propose for the separation of nickel and cobalt is that it permits us to determine the nickel without having to manipulate it in the state of sulphide—an operation always long, very delicate, and very troublesome.

Under favorable circumstances the analytic process that I have just explained will certainly be one of the most simple processes, and may be applied to the separation of nickel and cobalt on a large scale.—*Bulletin de la Société Chimique de Paris*.

PREPARATION OF CINNABAR.

MOST of the cinnabar (vermilion) used as a painter's color is still prepared in the dry way, at considerable trouble, and with uncertainty whether the shade will turn out right. There are several methods recorded for converting the black sulphide of mercury obtained in the wet way into red (cinnabar), but they do not so far seem to have met with any commercial success; at any rate, if such be the case, the particular plan followed has been kept secret. The best vermilion still comes from China, so that neither in the dry nor in the wet way have we as yet attained to that perfection in the manufacture of this article which is evidently possible among the Chinese. A discovery made last year in the technical laboratory of the Polytechnic School at Zurich promises, however, to solve the problem of obtaining any desired shade of cinnabar in the *wet* way. The starting point is corrosive sublimate (perchloride of mercury). A solution of this is poured into dilute ammonia. The ammonia must be in excess, so that after the "white precipitate" has settled the supernatant liquid may smell strongly of it. To this mixture, without filtering it, a solution of hyposulphite of soda is added in the first instance sufficient to dissolve the "white precipitate," and then something more. This solution is now gently heated in a dish, whereupon the cinnabar soon appears as a precipitate. Heating is continued till the mass has attained the state of thin mud. It appears as if the ammonia and chloride of ammonium existing in the solution played an important part both in forming the precipitate and in determining its shade. The temperature is also of importance concerning the appearance of the cinnabar. At 112° to 140° F. a lighter color is obtained than at 194° to 212° F. The finest shade is obtained at 158° to 176° F. Sometimes it does not come out as well, but running in a little more solution of hyposulphite is sure to produce it. When the desired shade has been obtained the vessel is taken from the fire. The precipitate is freed from all soluble substances by careful washing, and is then dried in the ordinary manner. It has also been tried to fix it on cotton fibre by saturating it with the solution of hyposulphite containing the mercurial salt, and developing the precipitate by steaming, but this operation only produces an orange color (probably owing to the extremely fine state of division of the mercuric sulphide). Further difficulties would be interposed against its use in printing by the necessity of avoiding any copper or brass in the printing blocks. (The sample of vermilion prepared in this manner, and forwarded by our esteemed correspondent, is of a highly satisfactory quality.)—*Chemical Review*.

SULPHUROUS ACID AS A DISINFECTANT.

By THOMAS W. KEATES, Consulting Chemist to the Metropolitan Board of Works, London.

FROM the remotest time burning sulphur has been employed to fumigate and purify infected air, and to destroy fermentative and putrefactive action. There is no agent more powerful in its effects than this. Unlike chlorine, it not only acts as a disinfectant or destroyer of disease germs and of the results of putrefaction, but it is also a powerful preservative agent, and, like carbolic acid, is a preventive of chemical changes in dead organic matter of every kind.

Although the value of sulphurous acid is thoroughly understood, its use is necessarily limited by the difficulty which exists in the way of producing it in a form in which it can be readily applied. The ordinary method of generating it by burning sulphur is cumbrous and very uncertain, owing to the difficulty of keeping up the combustion; there are also many situations in which the process cannot be carried on at all, and under the best circumstances it is inconvenient and but little under control. The evolution of the gas from its solution in water is scarcely more convenient, while it is much less effective; indeed, it may be said that there is no ready, convenient, and easily controllable way of producing this valuable agent in use at present; and this is the more remarkable when it is considered what a ready and simple means we really have at hand for this purpose.

Most of the readers of *The Lancet* are no doubt familiar, at least theoretically, with the substance called bisulphide of carbon. This is a compound of one atom of carbon with two atoms of sulphur (CS_2); it is a dense, mobile liquid, heavier than water, and intensely inflammable, burning in the air like spirit of wine. During combustion the constituents of the bisulphide combine with the oxygen of the air, producing sulphurous and carbonic acid gases; but as 100 parts contain, by weight, as much as 84 parts of sulphur, which will give, in burning, 168 parts of sulphurous acid, it will be seen that the volume of this gas from a given quantity of bisulphide greatly exceeds that of the carbonic acid, and is comparatively very large. Suppose the above quantities to be in grains: as 100 cubic inches of sulphurous acid weigh 68·5 grs., the 168 grs. will measure upwards of 245 cubic inches, or about one seventh of a cubic foot, which is the volume of sulphurous acid obtainable from 100 grs. of bisulphide.

The bisulphide of carbon can be burned in a common spirit lamp, and in that case the products are sulphurous acid and carbonic acid only, in relative proportion to the atomic composition of the bisulphide, as I have stated; but, by a modification of the method of burning, the amount of sulphurous acid produced in a given time can be regulated to any desired extent.

It is a property of the bisulphide of carbon to dissolve in fat oils and hydrocarbon liquids, such as petroleum; so, by mixing it with any one of these liquids and burning the mixture in a properly constructed oil or petroleum lamp, sulphurous acid will be generated with the other usual products of the combustion of such materials, and in proportion to the quantity of bisulphide present in the mixture of combustible liquids; any proportionate quantity of sulphurous acid can in this way be thrown into an atmosphere, and the action may be continued for any length of time.

As the sulphurous gas is generated *pari passu* during the combustion of the bisulphide, it diffuses itself in the air, which in a short time will become completely impregnated with it. In a room containing about 1,300 cubic feet of air it was found that by burning 280 grs. of the bisulphide the atmosphere was so far charged with sulphurous acid that it was impossible to remain in the room for more than a few seconds. In five minutes after the lamp was lighted litmus paper began to be reddened at some distance from it; in ten minutes the air had become very oppressive, and the litmus paper was reddened in the extreme corners of the room; in fifteen minutes the air was so charged with the gas that it could scarcely be breathed, and in twenty minutes it was unbearable. In that time, as I have said, 280 grs. of bisulphide were consumed in a simple single-wick lamp.

Sulphurous acid generated in this manner can be applied with facility to the disinfection of any place or object. In the case of rooms in which infectious or contagious disease has prevailed, it is only necessary to light the lamp and allow it to burn until the atmosphere has become impregnated with the gas to any desired extent, and then to remove or extinguish it just like a common spirit lamp. In the simple form of apparatus which I suggest for this purpose, the lamp is enclosed in a metal case, about 3 inches in diameter and 8 or 9 inches high, furnished with holes near the bottom for the admission of air, and others in the top for the emission of the sulphurous gas. This can be conveniently moved about, and placed, while the lamp is burning, in almost any locality. Receptacles for infected clothing, or the clothes or linen used in connection with disease, or carriages which have conveyed fever or other patients, can be thoroughly purified without difficulty and with very little trouble. For the disinfection of ships, too, the lamp is particularly suitable, as it can be carried into the remotest part of a ship and burned without the least danger, and with the certainty of effecting its object completely.

It must be observed that the bisulphide of carbon is extremely volatile, having its boiling point as low as 110° F.; it is therefore necessary that the lamp in which it is burned should be furnished with a well fitting screw cap, to prevent the liquid from evaporating, and at the same time to keep its peculiar odor from escaping. This odor is often very nauseous, but the bisulphide is now manufactured by Messrs. C. Price & Co., of Thames Street, London, England, so pure, that it possesses very little smell, and can be used without the least inconvenience.—*The Lancet.*

NEW TEST PAPER.

M. PIERRE MIQUEL.

THE author finds that sulphocyanic acid produces upon paper free from iron a carmine red spot, which disappears spontaneously on exposure to the air, and more rapidly if a gentle heat be applied. Ammoniacal vapors destroy the color immediately, and hydrochloric gas restores it. Thus a test paper is obtained far more sensitive than litmus.

WATERPROOFING WOOLLEN MATERIALS.

THE following method of rendering woollen textures waterproof is recommended: Boil 125 grammes (about 4¼ ozs.) of white soap in 12 litres (about 2½ gallons) of water, and separately dissolve 165 grammes (about 5¾ ozs.) of alum in 12 litres (about 2½ gallons) of water. Heat these two solutions to 190° Fahr.; then pass the woollen fabric once through the soap bath, and afterwards through the alum solution. Lastly, dry it in the open air.

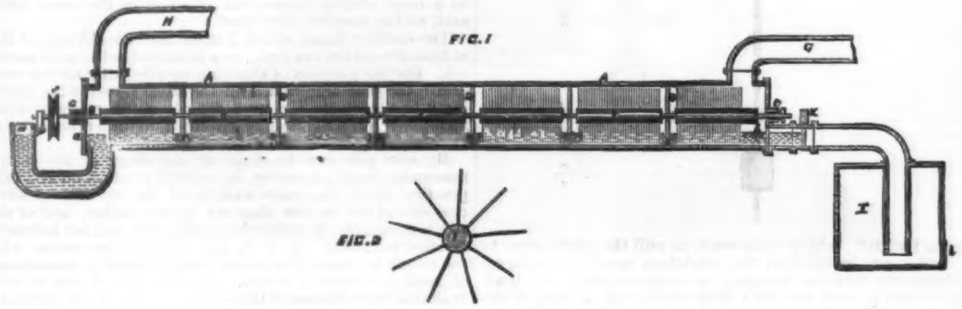
DECOLORATION OF INDIGO.

M. E. SCHAER.

IT is generally admitted that the decoloration of indigo by these agents is due to its transformation into white indigo, and, in fact, mere agitation in the air suffices to restore the blue color. But certain experiments seem to show that the decoloration is produced by the formation of a colorless molecular compound For indigo decolorized by hydro-sulphurous acid is regenerated, not only by the action of air and oxidizing agents, but also by decided reducing agents, such as sulphuretted hydrogen. Further, indigo bleached by the persulphide of hydrogen is restored by the action of sulphurous acid. These phenomena are explained by the decomposing action of sulphuretted hydrogen upon hydro-sulphurous acid, and of sulphurous acid upon persulphide of hydrogen. We may, then, admit that indigo combines with hydro-sulphurous acid and persulphide of hyhrogen, forming colorless compounds, which are destroyed with liberation of the indigo by all agents capable of destroying either hydro-sulphurous acid or persulphide of hydrogen.

STILL'S GAS PURIFIER.

FIG. 1 is a longitudinal section of this purifier. A A is a cylindrical case, and B a shaft, which runs the whole length of the cylinder, A; it has its bearings in stuffing boxes which are placed around it, where it passes through the ends, C C, of the cylinder; and also in the upright bars, D, D, D. E, E, E are a set of wooden rollers, affixed on the shaft B; they are studded with strips of whalebone, or other flexible material, throughout their whole length. A cross section of one of them is given in Fig. 2. The cylinder A, is filled to the height of the line *a b* with water, or a mixture



STILL'S GAS PURIFIER.

of lime and water, or any other suitable liquid or solution; the shaft, B, is made to rotate by means of a band from some prime moving power passed over the pulley, F. The gas to be purified is then allowed to escape through the pipe, G, and after passing through the machine it escapes by the pipe, H. When a fresh supply of water, or lime and water, is required, the previous or exhausted charge is allowed to flow into the vessel, I, by means of the valve, K, from which vessel it can be subsequently removed through the door, L. The fresh material is supplied to the cylinder through the pipe, M.—*Journal of Gas Lighting.*

SENSITIVE FLAME APPARATUS FOR ORDINARY GAS PRESSURE.

A GLASS or metallic tube, about 5 inches long, and ½ in diameter, is closed at one end with a perforated cork, through this cork slides a piece of ¼ inch tubing, about 6 inches long. One end of this is either drawn out to a jet, or closed in the blowpipe flame to reduce its diameter to about $\frac{1}{16}$ inch, and the other end is connected to a gas supply, (Fig. 1.)

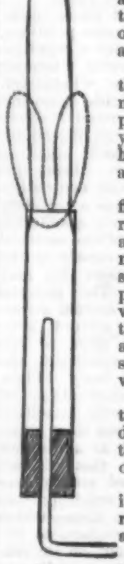


FIG. 1.

The outer tube is held in a suitable support, and the inner tube is pushed through the cork, till it nearly reaches the mouth of the outer one, and a light then supplied. It now gives a long steady flame.

EXPERIMENT I.—Lower the inner tube till the flame is on the point of roaring. It will now be found very sensitive to noise. Snapping the fingers at a distance of eight or ten yards will cause it to contract fully ½ of its height. The most suitable flame for this is about 6 inches high.

EXPERIMENT II.—Adjust the gas to give a flame of about 4½ inches high, and gradually raise the inner tube. A point will be reached at which the flame becomes sensitive, not to noise, but note; and it will be found to respond to a certain note by dividing into two portions, and while this note is produced it will continue divided. It is difficult to keep the exact note by whistling with the mouth, and therefore a glass whistle with paper slider should be used, or, better still, a singing tube with adjustment.

EXPERIMENT III.—Arrange two singing tubes to give the responding note. The flame divides Now make one tube a little sharper than the other, so as to beat slowly The alæ of the flame alternately recede and coalesce.

EXPERIMENT IV.—Using the whistle; blow it so hard as to produce higher octaves of the responding note. The flame will be unaffected as though in perfect silence.

The dimensions of the instrument are open to great variation, and also the size of the flame. For lecture work, a flame 1½ or 2 feet would be more suitable, though less sensitive, and neither dividing nor shortening so perfectly as the sizes given above. It will act effectively with any pressure of gas, from $\frac{1}{10}$ inch (of water) upwards, and the sliding jet makes it equally sensitive with a large or small gas supply.

ESCAPE OF GAS FROM CONTRACTED OPENINGS.

Glass tubes of about ½ inch bore are joined, as shown in Fig. 2. At D the tube is slightly bent so as to retain a little drop of water. The gas enters at C, and then divides into two channels, one towards B, the other towards A. If one of the exits be contracted, say B, then the water moves towards A. Certain precautions have to be observed, the conditional arrangements of which need not be mentioned here.

EXPERIMENT I.—Connect to each, A and B, a tapering jet, and C with the gas supply. Get the water stationary. Now light, say B, the water will move towards A, showing that the exit of the gas is retarded by being ignited.

This is rather a remarkable result, seeing that the gas is hotter, and therefore more mobile, and also that the heat must enlarge the aperture. Now light A, and the water will return to zero.

EXPERIMENT II.—Connect B with a sensitive flame apparatus,

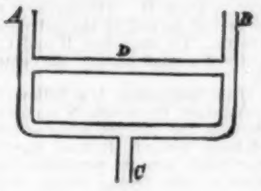


FIG. 2.

A remaining as before, light and adjust to zero. Now sound the responding note and the water moves towards A, showing that the outflow of gas is retarded by a certain note. Now adjust the sensitive flame for noise, and rapidly snap the fingers or stamp the foot, and the water will still move towards A.

EXPERIMENT III.—Arrange as in II., then extinguish the sensitive flame and readjust to zero. Produce the responding note, and the same movement of water will be observed.

This shows that an issuing jet is affected in the same manner by a sound, whether ignited or otherwise.

EXPERIMENT IV.—Fix the sensitive flame apparatus adjusted for note under a large jar open at both ends. A large stoppered gas jar answers very well. Fix three balls of spongy platinum, *a*, *b*, and *c*, upon a piece of thin platinum wire so that the point of the quiescent flame just reaches *b*, and the points of the responding flame reach *a* and *c* respectively. Now extinguish the flame without turning off the gas. The issuing gas will cause the ignition of *b*. Now sound the responding note, and *b* will cool, and *a* and *c* will be ignited. This confirms the previous observations, and forms a rather pretty lecture experiment. The object of the gas jar is merely to protect from air currents.—*Nature.*

R. H. RIDOUT.

THE CHEMISTRY OF COAL.

A COURSE of six lectures to workingmen on the above subject was lately given by Dr. Frankland, F.R.S., in the Chemical Lecture Theatre, South Kensington, in connection with the Royal School of Mines, London. The lecturer said there is no substance in nature, however common or apparently uninteresting it may be, which will not prove itself worthy of our attention if we examine it carefully, though it be merely a piece of sandstone, or even a brickbat. All of them have wonderful histories to tell us if we only apply to them those powers of observation and experiment which are always at hand; but no substance in nature, perhaps, has such a wonderful history and extraordinary properties as coal. To ascertain this history and these properties it will require more minute observation than is ordinarily bestowed upon it. Simple observation will readily show us that it is an opaque, brittle, hardish black substance; thrown on the fire it swells, gives off dense smoke, glows, and eventually burns. Coal is found embedded almost exclusively in certain rocks, named by geologists "coal measures," and the carboniferous system, in which these coal measures occur, stands far down in the geological series, as will be seen in the diagram. The coal is found interstratified with the other rocks of the coal measures in very thin seams compared with those rocks. The amount of this coal is, after all, very enormous, even the quantity we have in this country, and we have a very large share of the total coal worked in Europe at the present time. Arranged in order according to the amount of coal raised per annum, commencing with the highest, the following countries stand thus: British Isles, Germany, United States, Belgium, France, Russia, Austria, Spain. The following statements as to the amount raised yearly in the British Isles will, perhaps, be striking to some. If we were to dig a hole through the centre of the earth that hole would be 8,000 miles long; now, if the coal raised in one year in Great Britain were made into a bar 1 yard square, each yard of the bar weighing about 1 ton, the portion of the bar within the hole mentioned would represent about one seventh of the total quantity. Again, the circumference of the earth is about 24,000 miles, and if the coal raised in Great Britain in a year were made into a band 1 yard thick and 7 yards wide (each yard weighing, therefore, about 7 tons), that band would go all round the earth and leave about 3,000,000 yards to spare. The coal raised in four and a half years would bridge the space between the earth and the moon with a bar 1 yard square. The quantity raised in Great Britain yearly is between 100,000,000 and 107,000,000 tons. The quantity we possess is, after all, limited, and if we go on digging coal in this way it will before very long become a pressing problem how we are to prevent any waste of this valuable material. From the best sources of information, although it is very difficult to make an estimate, we have still to get, at less depths than 4,000 ft., only about 83,000,000,000 tons.

When closely examined coal is found to consist of vege-

table remains; in many cases it is only by microscopic investigation that this can be made out, but on examining the shale or clay associated with the coal impressions of leaves, stems, etc., of plants will very frequently be found. On the whole, there can be no doubt that coal has been formed from plants. Chemically speaking, coal is composed of what chemists call carbon, or charcoal, hydrogen, and oxygen, the two latter being gases, and these are also the constituents of plants, together with nitrogen, sulphur, and some other inorganic materials, which also occur in coal. So that chemical observation confirms microscopical and ordinary observation in saying that coal is formed from vegetables; it is quite a misnomer to call it a mineral in the ordinary language. The materials of which the plants built up their own substance (from which substance coal was produced in nature) were derived entirely from the atmosphere, and these materials are chiefly carbonic acid and water. Both of these exist in the atmosphere, though in rather small quantities, water being in the greater quantity. The great mass of the atmosphere is composed of nitrogen which took no part in the formation of coal, nor at the present day takes any part in the building up of plants. We may say that coal is primarily derived from the atmosphere through the agency of plants. And as carbonic acid and water are of vital importance in our enquiries into the chemistry of coal, it will be necessary to study their properties more in detail.

CARBONIC ACID.

When hydrochloric acid is poured upon marble (or vinegar upon chalk) an effervescence is set up, which is caused by the escape of carbonic acid gas, which can be collected over water. This gas is perfectly colorless and transparent; if a lighted candle is introduced into a jar of the gas the flame is at once extinguished, and the gas itself does not ignite—it is, in fact, a great enemy to combustion. The presence of this gas can be readily detected by means of a solution of baryta, an insoluble white solid—carbonate of baryta—being formed; lime water could also be employed, in which case chalk would be formed. The presence of carbonic acid in the air is proved by the fact that a dish of clear lime water which has been standing exposed to the air of this room is now covered with a white solid film of carbonate of lime. So delicate a test for carbonic acid is this clear baryta water that it becomes perceptibly milky by simply pouring it several times from one vessel into another. That carbonic acid gas is heavier than the air is proved by the fact that it can be ladled out from a vessel, or can be run off from a tap in the bottom, or poured from one vessel into another, while if poured into a vessel suspended and counterpoised on one arm of a balance that arm descends. This can also be shown in another way by the fact that a soap bubble dropped into a jar half filled with the gas rebounds on reaching the carbonic acid, and floats on its surface. The gas is, in fact, half as heavy again as the same bulk of air. So far carbonic acid does not seem a very promising material out of which to make coal, seeing that it will neither burn itself nor let other substances burn in contact with it. If this carbonic acid be subjected to great cold or great pressure, it can be liquefied, as we have it in this strong iron cylinder, on the interior surface of which it exerts a pressure of 900 lbs. to the square inch. A tube passes down nearly to the bottom of the vessel, and communicates with the exterior above, being closed by a tap; when that tap is opened some of the liquid is forced out, and a part of it at once volatilizes, or is converted into gas again. This volatilization of a portion greatly reduces the temperature of the remainder, so much, in fact, as to freeze it, and convert it into a white solid, looking exactly like so much snow.

That the solid is really carbonic acid is readily proved by putting a little into a jar and letting it volatize there, a lighted candle then lowered into the jar is immediately extinguished. The solid is intensely cold; if it be squeezed in the hand it blisters it, but it can be lightly handled without injury. If a tin can be set on a wet board, and some of this solid put into it and then moistened with ether, so as to bring it more closely into contact with the bottom of the tin, the latter will very quickly be frozen to the wood. By means of it, too, we are able to freeze mercury, which requires a much greater degree of cold than does the freezing of water. (The lecturer proved this by a very interesting and beautiful experiment. A mass of mercury was frozen by means of solid carbonic acid and ether, and while in the solid frozen state was hammered into a bar, thus proving mercury to be a malleable metal. The solid mercury was then held in a jar of water, which rapidly thawed the mercury, the latter descending in streams of globules to the bottom, each stream freezing an icicle in the water.) The temperature of this solid carbonic acid is not less than 128° below the freezing point of water. Looking a little more minutely into the constitution and properties of carbonic acid, we find it to be a compound—*i. e.*, a substance out of which we can get two substances each differing from the original carbonic acid. Thus by heating a piece of the metal potassium in carbonic acid gas the metal burns (thus there is something which will burn in the gas), and in so burning it expels one of the constituents of the gas, which remains as a black solid, and which, in fact, proves to be carbon or charcoal. The other constituent is oxygen, which is not so readily obtained separately out of the carbonic acid; nevertheless, we can prove that carbonic acid is composed of these two constituents by burning carbon in oxygen, and by means of the baryta water proving that carbonic acid is produced. This carbon is met with in nature in three distinct forms—as charcoal, as graphite or plumbago, and as diamond; each of these when burnt in a jar of oxygen forms carbonic acid, and from the carbonic acid, as already shown by means of the metal potassium, we can get back the carbon in the form of charcoal, less readily in the form of graphite, but no one has yet succeeded in getting back the carbon in the form of diamond.

You will, therefore, begin to see, since it is possible to get carbon out of carbonic acid, and since carbonic acid exists in the air, how Nature manufactures her coal.

CHEMICAL SOCIETY, LONDON.

Professor ABEL, F.R.S., President, in the Chair, December.

A PAPER, by Mr. W. N. Hartley, entitled "A Further Study of Fluid Cavities," was read, and the results of his examination of a large number of topazes selected from the magnificent collection in the British Museum showed that the cavities scarcely ever contained anything but water. If the view be accepted that topaz has been formed by the action of alkaline fluorides or cryolite on kaolin, no carbon dioxide would be liberated, so that it might not necessarily be found in the fluid cavities. This is corroborated by the fact that in one and the same topaz cavities exist side by side, one of which is nearly filled with liquid carbon dioxide, the other one third with water, one third with liquid, and one third with gaseous carbon dioxide, the space occupied by the gaseous CO_2 having been produced by the contraction of the water on cooling. He inferred, moreover, that the critical temperature of water had not been reached, otherwise the contents of the adjacent cavities would have been uniform.

The author has also examined a very large number of rock sections, principally granite and porphyries, almost all of which contained water cavities, but in none of them was the presence of carbon dioxide distinctly proved. A curious phenomenon in connection with the bubbles in the water cavities of rock crystal was sometimes observed, namely, that when heated the bubble became more dense than the liquid and sank, so that in large, deep cavities they went entirely out of focus when observed with a half inch objective. In one specimen of quartz it was found that the bubble began to sink at 150° C., but not before it had reached this temperature. The cause of this motion appears to be that the bubbles consist of a gas so highly compressed that it is nearly of the same density as water at the ordinary temperature; on heating the water expands, thus still further condensing the gas in the cavity, which then becomes heavier than the liquid, and consequently sinks in it.

It is very remarkable that the cavities are not only frequently arranged symmetrically around the axis of the crystal, but in some cases they take the form of the crystals in which they are enclosed, each side of the cavity being parallel to a face of the crystal. Drawings of sections of crystals were exhibited, in which this was very clearly shown. This is probably caused by the water exerting a resistance to compression comparable to a solid body at the high temperature at which the crystal was formed, but being mobile the shape of the enclosed water was altered, so as to conform to the planes of crystallization of the mineral as the silica molecules grouped themselves around it.

The President, in thanking the author, remarked that this investigation in his hands had been prolific in interesting results. He hoped that his ingenious speculations, bearing on the formation of these crystalline substances and the cavities contained in them, would give rise to a valuable discussion.

In reply to a question put by Dr. Armstrong, with reference to the occlusion of hydrogen by trap rocks, recently investigated by an American chemist, Mr. Hartley said that in samples of trap from the neighborhood of Edinburgh which he had examined, he had noticed cavities, but they contained nothing; cavities containing liquefied carbon dioxide had been observed, however, in trap. He had not considered the question as to whether such cavities contained hydrogen; his attention had been chiefly confined to quartz, granites, porphyries, etc., as most likely to have cavities containing liquefied carbon dioxide, the special object of his search.

Dr. H. E. Armstrong then gave a paper "On Thymoquinone."

A paper "On High Melting Points, with special reference to those of Metallic Salts," by Dr. T. Carnelly, was read. The method to be employed depends on the principle that if three salts A B and C, whose fusion points are in the order A, B, C, be arranged on a cold block of iron, and then introduced into a muffle kept at a constant high temperature, the ratio $\frac{y}{x}$ is approximately constant for the same three salts, whatever the temperature of the muffle: x being the number of seconds which elapse between the melting of A B; and y, that between the melting of B and C. The arrangement of the muffle and iron blocks is shown in an engraving, and the methods of working given in detail. The results of a large number of experiments, instituted to prove that the law just enunciated holds good under varying circumstances, is given in a series of tables. The author proposes, in a future communication, to show how this principle may be employed in the actual determination of high melting points.

The secretary then gave an outline of a paper "On the Estimation of Urea," by Mr. G. Turner, containing the results of his experiments in determining urea by Russell & West's method, the apparatus employed being a modification of that known as "Schiebler's calcimetor."

Dr. G. Bischof read a short notice "On the Corrosion of Lead by the New River Company's Water," saying that he had observed the formation of a crust of lead carbonate on the exterior of a piece of gas tube which had been employed as a syphon in a cistern supplied by the New River Company, and which was consequently alternately exposed to the action of air and water, as the level of the water in the cistern altered. This tube was the so-called "composition" tube usually employed by gas fitters, consisting of lead alloyed with a little antimony. An adjoining cistern of sheet lead with a lead overflow pipe shows nowhere any signs of similar corrosion.

In reference to a remark which the author made as to the protective influence which tin exerted when alloyed with lead, Mr. David Howard said that even when the amount of lead in the tin used for tinning vessels employed for culinary purposes did not exceed 5 or 10 per cent. it was found to be readily attacked by dilute acids, so as to be likely to produce very injurious effects.

The President said that, in the lead tubes lined with tin which was made by drawing the two metals at the same time, when faults occurred in this interior, coating the lead was rapidly corroded, although no doubt the faulty parts must be more or less alloyed with tin.

COLOR AND COLOR CHANGES.

By ISIDOR WALZ, PH.D.*

Preliminary Notice.

As I am aware, E. J. Houston† was the first to announce the law that the changes of color which certain substances experience under the influence of heat follow a certain order, viz.: *the order of the colors of the solar spectrum*. The subject has since received further attention,‡ and the terms *metachromatism* and *thermochromatism* have been proposed wherewith to designate this class of phenomena.

I desire to place on record here in a preliminary note some observations which I have made in a similar direction. While engaged in studying the phenomena of solubility in connection with the specific volumes of substances,§ I repeatedly found what I believed to be clues pointing to a connection between other physical properties of substances (such as volatility, etc.) and their specific volumes, of which none interested me more than those relating to the color of substances. I have since continued to follow up this subject, and believe to have undoubtedly demonstrated certain regularities; but since my material is still incomplete, while at the same time my health compels a suspension of labor for a considerable time to come, I trust to be excused for presenting an incomplete report of my work.

The law that "substances change color in the order of the spectrum colors under the influence of heat," I believe to be far more general, *the same order being observed in a large number of reactions in which color change is induced by chemical action.* If any one will take the trouble to examine, *e. g.*, the color reactions of the alkaloids in Dragendorf's *Gerichtlich-Chemische Ermittlung der Gifte* (p. 235 *et seq.*), he will readily concede this. I will only instance the color change of veratrine with pure sulphuric acid, viz.: yellow, orange, blood red, crimson. As a remarkably striking example, however, I will select Adam Klewicz's color reactions of albumen, as described by himself.* In pure concentrated sulphuric acid, albumen dissolves with a definite color. If we add to this acid in a test tube dilute egg-albumen drop by drop, while agitating the same cautiously, the solution of the albumen is effected, attended by a color change that commences with green and ends with a deep violet. Green is changed in the first place to yellow, the yellow runs through its several stages of saturation, passes into orange and finally into red, from which the color scale follows various shadings down to dark cherry red. The color change ends at last in a deep violet, which forms the terminal reaction of the albumen solution in sulphuric acid. Farther on the author gives the following tabular statement, when sulphuric acid of 1·8095 sp. gr. is used.

Abumen-Sulphuric Acid.

Percentage of Albumen,	1·5		7	15 ...	22
Color of the Solution:	Green,	Yellow.	Orange.	Red.	Violet.

One great difficulty in the pursuit of a research on color is the varying designation of the color of the same substance by different writers, *e.g.*, the use of purple and violet as synonymes, although purple (as well as crimson) belongs to the red end of the spectrum, and violet to the other extreme.† The detailed description of the color change in red, in the above reaction, fully justifies us in substituting the word purple for the violet used by the author, thus making the series absolutely perfect, viz.:

Green, Yellow, Orange, Red, Purple.

As another example of a color change in the order of the spectrum colors, induced by chemical action, but in the inverse order, I cite from the following reaction of vanadic acid.‡ "If the *dark red* solution of vanadic acid, prepared with boiling sulphuric acid and diluted with fifty times the quantity of water, is gently warmed with zinc, the vanadic acid passes successively under *blue* coloration into tetroxide, under *green* coloration into trioxide, and lastly under *violet* or *lavender blue* coloration into dioxide." The series here is only interrupted by the appearance of the blue before the green color, a phenomenon which also occurs in other series, and on the cause of which I hope further research will throw some light. On the other hand, the description, or "lavender blue," leaves us no doubt that violet is here used in its proper sense.

The allotropes of phosphorus offer an interesting case of color change *in spectrum order with increasing density.*

Phosphorus.

Color.	White.	Deep Red.	Orange Red.	Violet Gray.
Specif. Gravity,	1·836	2·148	2·19	2·293
	Pisati and DeFranchis at 0° C.	Determined by Troost and Hauterfeuille at 0° C.		

Designating the color of iodine and its vapors as purple (which may be justified, I think, by the color of its solutions in solvents that tend to red and brown, but not to violet, by the diathermancy of its solution in carbon disulphide to the ultra-red rays, etc.), we have in the well known halogen group an instance of *color progressing in spectrum order in a group of analogous substances*, viz.:

Chlorine.	*Bromine.*	*Iodine.*
Greenish Yellow.	Red.	Purple.

The solutions of sulphur, selenium, and tellurium show a similar color series. Instances of this kind are quite numerous among compounds. Taking, *e. g.*, the chlorine, bromine, and iodine compounds of lead, silver and mercury, we shall find the iodides nearer the red end of the spectrum in color than the bromides, and the latter nearer than the chlorides. In a similar manner the sulphides of many metals are colored, while the corresponding oxides are colorless, *e. g.*, the metals of the alkalies and alkaline earths. Again, taking series of oxides, chlorides, etc., of one and the same element, we also frequently meet with this regular progressive variation of color, the latter *generally, but by no means always, shifting from the violet to the red end of the spectrum, as we rise in the series*—subject, however, to anomalies, such as the apparent transposition of two contiguous colors. Thus, according to Berzelius (Handbuch, s. v.), ferrous oxide, in oxidizing, passes through the following series of colors: gray, *green*, *dark blue*, yellowish brown. (Here we find again the blue and green transposed, as it were, as in the case of the vanadic oxides quoted above. This particular anomaly would seem to be quite frequent.) The compounds and salts of iron, manganese, chromium, uranium, vanadium, etc., furnish numerous instances in which this regularity may be traced.

The above facts may suffice for the present. I hope to be able to prove, by a fuller presentation at some future time, that *when a series of color changes is imitated by chemical action, the colors appear successively in the order of the spectrum; that when, as in phosphorus, the color of a substance changes with its physical condition, the changes occur in the order of the spectrum, progressively with the change of physical properties, such as density, specific volume, etc.; and that in series of colored compounds of analogous or similar atomic constitution, the colors are in the order of the spectrum*, generally, as I believe at present, passing from the violet to the red end as we rise in the series. There is abundant cause, in my opinion, for the belief that the color of a substance is intimately connected, not only with the chemical constitution, but also with the physical constants (density, specific volume, molecular weight, etc.), of its molecules; and possibly we may yet arrive at a knowledge of the actual dimensions of the molecules of colored substances by data obtained from the wave length corresponding to the colors which they transmit or reflect.—*American Chemist.*

* (Read before the American Chemical Society, Oct. 5, 1876.)
† Journal of the Franklin Institute, Oct.. 1871.
‡ W. Ackroyd. Chem. News, xxxiv., p. 75.
§ Am. Chemist, Feb., 1875.

* Pflueger's Archiv für Physiologie, X., 156.
† Compare Helmholtz, Physiol. Optik., p. 227.
‡ This description is taken from Jahresber. für Chemie, 1867, p. 241.

CARBON DISULPHIDE FOR DISINFECTION.

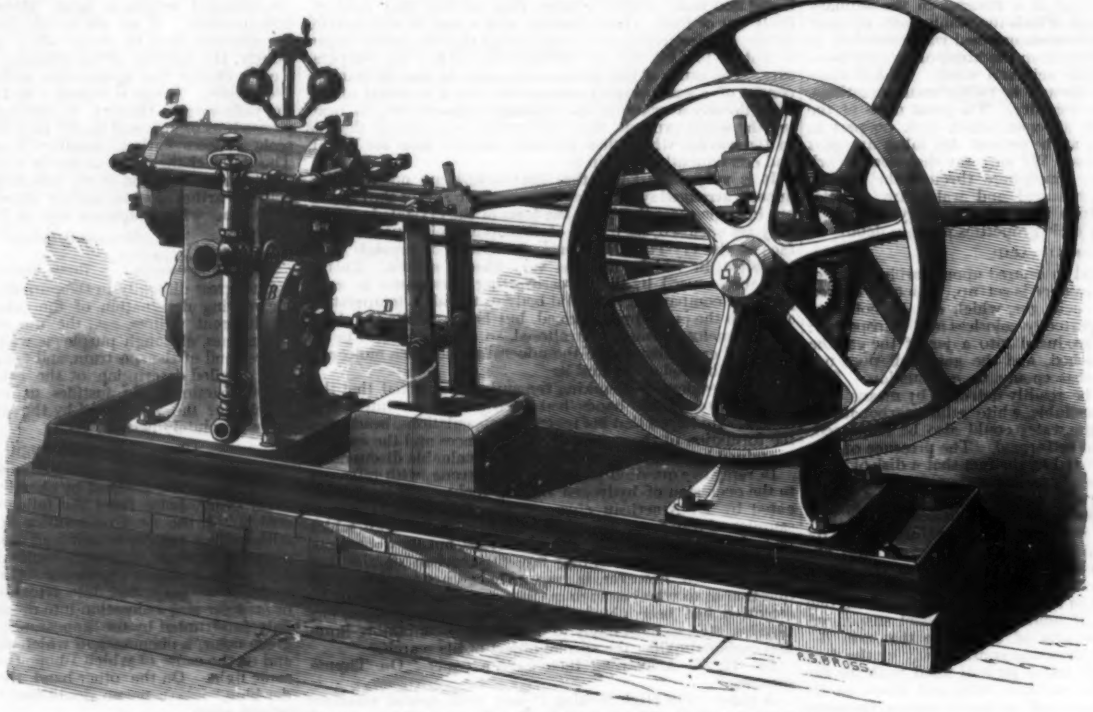
WE recently published an article on this subject, to which the experience of Mr. Thos. Stevenson may be added. He says: "I have used sulphurous acid generated exclusively from the combustion of carbon disulphide, as a disinfectant for rooms, during a period of nearly seven years. No special form of lamp is required. The requisite quantity of the disulphide may be placed in an ordinary porcelain or copper dish placed on a tripod, and ignited with a match. In five minutes several ounces of the liquid may be easily and safely burnt."

BRAYTON'S HYDROCARBON ENGINE.

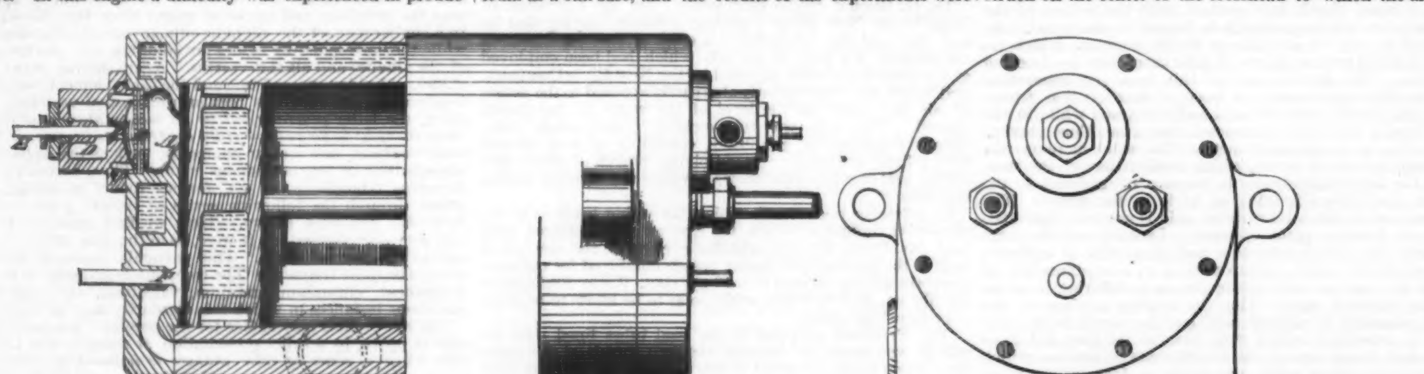
WE present in our accompanying illustrations a form of engine which we are informed is coming into rapid use. It is the invention of Mr. George B. Brayton, an engineer of noted ability, who has devoted twenty-five years to its production and perfection. There has of late years been an active demand for a motor that would dispense with the use of steam, more especially in those cases in which the use of an engine was only required to be intermittent throughout the day, because in that event the consumption of fuel is continuous, and the boiler requires attention, though the engine is not running. Outside of this, however, the use of steam boilers is always objectionable, unless unavoidable.

In the course of Mr. Brayton's experiments, he has constructed several totally different kinds of engines, some of which are still in use, his present engine as here illustrated, however, is so great an improvement upon all previous ones, that, bearing the same name, it becomes necessary to give a short review of the history of the invention in order to disassociate this latest from former productions:

In the first of Mr. Brayton's engines which were made double acting, separate charges of hydrocarbon were exploded, the force acting on a free piston to compress air, which in turn was used expansively upon the working piston; subsequently a rack and reversible catch or pall held the piston, and a vacuum was used in connection with the air pressure. In this engine a difficulty was experienced in producing an explosive compound of a uniform power, and in designing a safe and reliable mechanical means of igniting the same. Some of the designs experimented upon to this end exhibit unusual originality and ingenuity, but in the end the inventor became convinced that this form of engine could never be made satisfactory, and he turned his attention to the design of an engine in which an explosive mixture could be gradually consumed without the ordinarily explosive action, and he proceeded to construct experimental engines, designed with this end in view. During the trial of these engines a new difficulty was experienced in the production of the vapor compound, owing to its tendency to condensation under high pressures, and the effect of every varying temperature upon the evaporation which seemed for a while to baffle all the inventor's ingenuity, and which, finally, induced a new course of experiment, substituting coal gas for liquids. Several engines of the latter kind were constructed, Mr. Brayton obtaining his first patent in 1872, on nineteen years after his devotion to the subject, and one of these engines is now in operation in this city. One of them was exhibited before the Massachusetts Institute of Technology in 1870. It was subsequently exhibited at the American Institute Fair, and was tested by Professor R. H. Thurston, and several other engineers, who gave very promising reports of its performance. The inventor, however, on account of the abundance and cheapness of petroleum, again turned his attention to the production of a vapor engine with petroleum as a full base, and the results of his experiments were evidenced in a ten horse double acting vertical engine exhibited in Machinery Hall at the Centennial, which engine gave upon trial 12¼ H. P. Previous to its construction, however, several small horizontal engines, varying from 1 to 5 horse power were constructed, some of which have been running for the past year or two in this city. Their performances have been at all times well reported upon, and some of them have been in continuous operation without any intermission for repairs; in others, however, faultiness in construction, added to the fact that they were run by those having no knowledge of engines or machinery, instead of having the ordinary engineer, led to their giving frequent trouble in getting out of adjustment. In consequence of this, Mr. Brayton took into his own hands the supervision of the manufacture, and from that day the engine has rapidly developed. Two of the single acting engines made under his supervision were used day and night, Sundays included, for six months in Agricultural Hall, at the Centennial Exhibition, pumping water for the Aquarium. The indicator card shown was taken from the 10 H. P. vertical, exhibited at Philadelphia, and disposes at once of any supposition that the action of the cumbustion is explosive. The principles upon which the engine is constructed may be thus briefly described: In Fig. 1, A is the working cylinder, and B the air pump. Instead, however, of having a crosshead and slides, a parallel motion for the piston is provided, as follows: In Fig. 1, C is a lever, the lower end of which is a radial foot, the circle being struck off the center of the crosshead to which the arm, on



BRAYTON'S HYDROCARBON ENGINE.



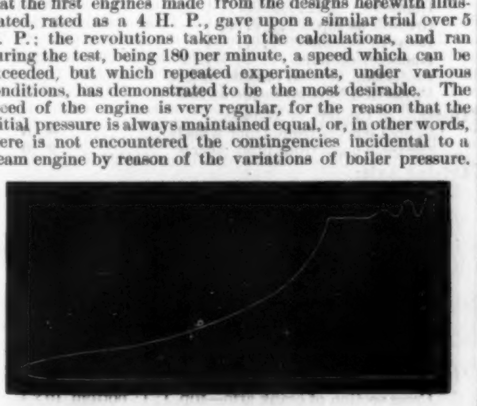
BRAYTON'S HYDROCARBON ENGINE.

lever C, is pivoted by a journal. The radial foot of C rests upon a pathway, parallel with the bore of the cylinder; hence, as the piston crosshead moves along, the radial foot rolls along the pathway. This motion, it will be observed, is practically frictionless. It is imperative, however, that the engine runs with the top of the flywheel revolving in a direction away from the cylinder, so that the angularity of the connecting rod shall always keep the radial foot down upon the pathway. The method of forming the combustible compound is shown in Fig. 2, in which it is shown, in the sectional view, that the cylinder cover is provided with a chamber which performs three functions: the first to vaporize the petroleum, the second to ensure safety, and the third to maintain continuous combustion, and thus avoid having to light the vapor at each stroke. In Fig. 2, A represents the combustion chamber in which the vapor burns continuously, and B the safety device which is composed of perforated plates with diaphragms of wire gauze between them, which, on the principle of the Davy lamp, renders it impossible for the flame in the chamber to pass through. At C is shown an annular groove, packed with felt or sponge, into which the petroleum is fed by a small pump. A small jet of air is also introduced into the fibrous material while it is moistened with the petroleum. As the supply of this jet is constant and under considerable pressure, the result is that the petroleum is forced out in the form of spray, which is spread over and absorbed by the meshes of wire gauze. The air in volume is admitted from the chest D (through the valve E), to fill the cylinder. This volume of air (which is under a pressure, varying from 30 to 75 lbs., according as regulated to suit the duty), in passing through the gauze takes up the spray, mechanically evaporating it as it enters the combustion chamber. The small air jet is carbonized to a degree rendering *its* combustion continuous, as previously indicated. To start the engine, the two plugs E E in Fig. 1 are taken out of the cylinder and the small pump is worked by hand; through the means of the hand wheel, shown on the top of the governor, the air jet is then let on, and a match is applied to the holes from which the plugs were removed; so soon as the combustion takes place the plugs are reinstated and the supply of air from the reservoir is turned on, whereupon the engine starts instantly. Were the combustion carried to its utmost practical limit, there would be left a mineral residue liable to prove destructive to the piston; hence, the combustion is not carried to this limit, and the result is the formation in the cylinder of a comparatively heavy oil, which serves as a lubricant to the piston. The piston of the 10 H. P. engine at the Centennial was found on a recent examination to be bright and smooth, with the turning marks plainly visible, evidencing favorable conditions for wear. In Fig. 2 the dotted lines indicate the water passages by which the cylinders and the working piston is kept as cool as may be desired.

The motive power then is produced by the whole products of combustion acting upon the piston. The point of cut off is regulated by the point at which the valve F closes. The exhaust takes place through the valve F, which is operated by a positive motion, all the valves being operated from one shaft, the valve F being acted upon by the governor. The inlet valves for the air pumps are shown at G G; they are connected together by a rod, and act automatically. The air pump discharge valves are shown at H H, the hole I being for the purpose of attaching a pipe to an independent air receiver, which is in some cases required, as, for example, when an engine has to perform for a short period of time a duty much above its average allotted duty, in which event the air may be stored in a separate receptacle while the engine is under its light duty, and when the load is excessive the air pump may be either wholly or partially relieved of duty while the air stored is being used. To provide sufficient air pressure to start the engine in the morning the frame of the engine contains an air reservoir, the hole I being plugged up unless the extra air reservoir referred to is employed.

It will be observed that the lift of the valve H is made a definite amount by means of a set screw near the end of the spindle, and its quantity is proportioned according to the size of the engine.

In defining by actual experiment the exact proportions of the various parts and movements, Mr. Brayton has found but little difficulty, the great problem being how to generate a continuous combustible compound of air and the hydrocarbons, and apply it under high pressure to a working piston, and he has from his experiments so mastered his subject that engines are now designed with unusual certainty as to the results to be obtained, whether the engine be of the smallest size (½ H. P.) or of the largest, the inventor rating his engines at what he estimates as their actual power allowing a margin. It has been said that the 10 H. P. at the Centennial gave a brake test of 12½ H. P., and it may be added that the first engines made from the designs herewith illustrated, rated as a 4 H. P., gave upon a similar trial over 5 H. P.; the revolutions taken in the calculations, and ran during the test, being 180 per minute, a speed which can be exceeded, but which repeated experiments, under various conditions, has demonstrated to be the most desirable. The speed of the engine is very regular, for the reason that the initial pressure is always maintained equal, or, in other words, there is not encountered the contingencies incidental to a steam engine by reason of the variations of boiler pressure.



The indicator card shown in our engravings is one taken from the 10 H. P. Brayton engine at the Centennial, and it conclusively demonstrates that the action of the products of combustion is precisely the same as is the action of the steam in an ordinary engine, the point of cut off being unusually sharply defined, and the expansive curve very true and regular. The workmanship on these engines do credit to the Exeter Machine Works in New Hampshire, where they are now made under the inspection of the inventor.

For further particulars, address the Penn. Ready Motor Co., 20 North 4th street, Philadelphia, Penn.

NEW YORK CENTRAL RAILROAD.

THE total length of single track owned and operated by the New York Central Railroad Company, is 2,438 miles. The weight of the rails, on the main track, all steel, is 65 lb. per yard. The company has 61 engine houses and shops, 557 locomotives, and 8 dummies, 416 first class passenger cars, 83 second class and emigrant cars, 215 baggage, mail, and express cars, and 15,310 freight cars. The aggregate distance run by passenger trains in the year ending September 30, 1876, was 4,743,485 miles, by freight trains 9,278,266 miles, and by switch and work trains 4,224,856 miles, making an aggregate of 18,246,607 miles. The average rate of speed of ordinary passenger trains, when in motion, was last year 30 miles per hour; of express passenger trains 35 miles per hour; and of freight trains 15 miles per hour. The weight of the freight trains averaged 400 tons.

ICE BLASTING EXPERIMENTS.

THE following particulars are from a paper recently read before the Civil Engineers' Club, Chicago. They relate to blasting experiments made in 1874-5 on Kankakee River. The ice was 26 inches thick:

Two experimental blasts were made, using in each case a 6-lb. can of rifle powder. A waterproof fuse 15 feet long was inserted and carefully packed with putty, the can was securely fastened to the end of a 2x4 scantling 12 feet long, and the fuse attached by twine to the scantling. A hole of sufficient size to allow the can and attachment to be put through was cut in the ice and the can was pushed in 12 feet beyond the hole, being kept against the ice by the float. The result of each explosion was to break into small pieces a portion of the ice field 15 feet in diameter, and to visibly crack the ice below its surface, in several places, for a distance of some 20 feet beyond the broken centre. A number of pieces were thrown 50 feet or more into the air.

A number of one quart oyster cans were procured, and next day several more blasts were discharged. These cans when filled held, each, 1¾ lbs. of F F Fg sporting powder, and this charge gave the best results, breaking up the ice for a space of about 30 feet in diameter, and throwing out cracks for 30 or 40 feet more. The greatest execution was done when the blasts were exploded at a considerable distance from the places previously blasted out, that is, in the unbroken ice field. A charge of one pound of powder did not fracture the ice. A 6½-lb. can of Dupont's sporting powder opened a hole 30 feet in diameter and threw many pieces of ice, several feet square, perpendicularly into the air, probably a height of 150 feet, the fragments falling within a radius of 100 feet. The seams in the ice, however, were not opened to any greater distance than in the 1¾-lb. charge. Ordinary blasting powder was tried, but it did not break through the ice. A charge of 19 lbs. had the effect to raise the whole mass of ice extending across the river several inches, but without producing a fracture. A similar charge exploded six feet below the surface had no immediate perceptible effect. After the explosion of these charges, however, the ice for a distance of 500 or 600 feet up the river appeared to be seamed with cracks and ready to go to pieces.

Ordinary blasting powder does not explode with sufficient rapidity. The cans used with the 1¾ lb. charges were ordinary oyster cans, the round cover being cut in the centre with a +, and this punched through from the inside. The four projecting points encircling the fuse being turned back a little seemed to retain the putty packing in place.

HIGH PRESSURE BOILERS.

AT a recent meeting of the North Stafford (England) Mining Institute, Mr. Adamson, in the course of the discussion on a paper descriptive of sectional boilers, said, he had been much interested in the manufacture of high pressure boilers. In the sectional boiler under notice there were five tubes, two on the right and two on the left of cylinders, the diameters being small, with no corrosive heat and no destruction of brickwork. There was no loss of power, no great wear and tear, as in the old cylinder boiler; but there was no boiler with so great a reserve power as the old cylinder boiler. For colliery purposes, where very poor fuel could be got at a low cost, the cylinder boiler had merit if the water was not dirty; but if the water was bad and contained much lime, it became dangerous by adhering to the plates. Cylinder boilers contained ten gallons of water to one square foot of heating surface, and any drawing away of the steam lowered the pressure, latent heat already stirred up flashed into steam, and the boiler sustained good pressure under intermittent action. It contained a larger body of water for its heating surface than any other boiler. The chimney boiler, at work amongst forges, carried as far as fourteen gallons of water to the square foot of heating surface. The quantity of heat was so enormous as to make them comparatively steady steamers. That was the reverse of all sectional boilers aiming to carry small quantities of water. With regard to tubular boilers, there was nothing new in them, except as to the way in which they were arranged. They could not keep the pressure steady if they had a variation of diameter. If they had a boiler with a pressure of 50 lb. to the square inch, and heard of priming taking place, they might set it down that it had not a heating surface commensurate with its requirements. If they had a 100 lb. pressure, and a certain quantity of water reduced into 90 lb., they jeopardized the engine. If the Howard boiler had never been seen, many persons would have been saved a considerable expenditure of money. The Lancashire boiler had perhaps been adopted more than any other work at a pressure of 100 lb. to the square inch. It carried five gallons of water per square foot of heating surface. Water had to convey all the heat, transmit it to the surface, and, unless they had a given quantity of water to a given quantity of steam, they had internal havoc going on, while they thought there was nothing but safety. Boilers, constructed to contain a small quantity of water and do a great amount of work, could not absorb the heat with sufficient rapidity to remain steady heaters and steamers. It was an utter waste of power to construct tubular boilers to produce a great amount of steam with a small quantity of water, and as soon as the pressure was withdrawn violent ebullition took place, and the water could not carry the steam away. They wanted medium sized boilers to do a fair measure of work in proportion to the fuel used, which could not be gained by boilers of the Howard type. They could not force water to go out of its way to do their bidding. There was a law of absorption and a law of getting rid of heat, and a boiler of the tubular structure never could get rid of the heat. What was called circulation ought to be called confusion. Sectional boilers contained more water than some other kinds, but he had no doubt they contained so little water as to be dangerous. Until they had demonstrated to the contrary, they must adhere to some approximation of five gallons of water to a square foot of heating surface, and if they had only half that quantity they had a dangerous machine. In all cases where they wanted security they must have sufficient conveying medium to get rid of the heat as well as absorb it. He condemned the "safe and sure" boiler, and advocated the manufacture of boilers from iron made by the Bessemer process.

FRACTURE OF RAILWAY TIRES.

AT a recent meeting of the Institution of Civil Engineers, Mr. George Robert Stephenson, the President, in the chair, the paper read was on "The Fracture of Railway Tires," by Mr. W. W. Beaumont, Assoc. Inst. C. E. It was stated that, between the years 1847 and 1874, eighty accidents from broken tires, attended by serious results, had been reported upon by the officers of the Board of Trade. The total number of tires fractured was not known, as previous to 1872 the railway companies made no return of such accidents; but, since 1847, tire fractures had resulted in the loss of seventy-four lives and two hundred and thirty-six cases of serious personal injury. So far as the author was aware, no satisfactory explanation had been given of the forces productive of fracture of tires of good material and workmanship; it was the object of this paper to suggest a cause for their origin. Some of the theories advanced to account for tire fracture were treated of; such as the strain due to shrinking tires on to wheel bodies, the reduction of the sectional area by rivet or bolt holes, and the alleged reduction of the strength of the tire by low temperature in winter. These causes were considered to be inadequate to account for:

1st. The fracture of a good tire; 2nd, the fracture of tires in several places simultaneously; 3rd, the fracture of tires through the solid body rather than through bolt or rivet holes; 4th, breakages being few in number for a long period, and then occurring frequently; and 5th, tires, generally of considerable age, running several thousand miles before flying to pieces.

For an explanation of these facts the author appealed to internal differential molecular strains, generated in the material of tires, by extension and compression from their surface inwards, consequent upon their rolling at high velocities, under heavy loads, along the hard, smooth, and somewhat rigid permanent way. If a piece of flat, stout plate metal was subjected, when cold, to long continued light hammering, or rolling, on one of its surfaces, that surface would become compressed and elongated. The effect of thus altering the relative dimensions of the two surfaces of the originally flat plate would be to make it assume the form of an umbo, with the convexity towards the rolled or hammered surface. In illustration of this, reference was made to the straightening of copying plates, or other plate castings, which had become bent in cooling, by lightly hammering the concave side and thus elongating that side. Another example was afforded in the curvature produced in train plates—for instance, those on Westminster Bridge, London, by the extension and compression of the surface exposed to the rolling under the loaded wheels of vehicles. Similarly, film after film from the surface inwards of the material of a railway tire was compressed until the thickness molecularly altered induced internal differential strains sufficient to rupture the tire, or so nearly to effect it, that an unusually heavy impulse, or other extraneous force, was alone necessary for such a result. As these strains approached equality throughout the tire, the length, and therefore the number of pieces into which the tire would be broken, would be determined by the limit of stability and the co-efficient of elasticity of the material. Absolute simultaneity of multiple fracture was not a necessary condition of such a result, as the precedence of one fracture would liberate the tire, so that the internal forces would be free to initiate fracture in as many places as might be necessary to expend the excess of the forces tending to rupture, over those of resistance to it. Of the reported fracture of tires, affixed by rivets or screws, nearly one-third were fractured through the full section, and not a bolt or rivet hole; thus indicating that those tires were either strongest at the reduced section, or that the internal forces tending to produce fracture were greater between than at the rivet or bolt holes. In tires of good material and workmanship fracture would be expected to take place rather between than through such holes; for at these the continuity of the material was broken, so that the tangential compression, produced in the outer portions of the tire by the impeded elongation of the material, was dissipated by an upward flow of the particles round such holes. This upward flow tended to produce a crater-like ridge, which was quickly worn off, so that the tire at these points was relieved of strain, the material that would have exerted it being carried away. Elastic wheels could only be considered as a palliative, for the tire had still to support a load, so that its surface would be subject to compromise, although the mischief would not proceed so rapidly as with a nearly rigid wheel. The inertia of impact strain upon a rigid wheel would have to be overcome by the tire before it was relieved by the springs of the vehicle, whereas a good elastic wheel possessed in some degree the character of a spring, and in so far was without any such inertia. However good the material and workmanship of a railway tire, and in whatever manner affixed, it must gradually become unsafe, from other reasons than simple loss of thickness, for whether it was of steel or of iron it was amenable to the production and accumulation of molecular strains. The great durability of American chilled wheels was probably owing to the extreme hardness of their running surfaces, and their consequent resistance to surface compression. Although the ultimate strength of a tire was probably not reduced by the bolt or rivet holes, the preferable method of fastening was unquestionably by continuous clips and grooves on both sides of the tire, so as to prevent the portions of a fractured tire from leaving the wheel. It was to this latter cause, rather than to simple fracture, that many lamentable accidents were to be ascribed.

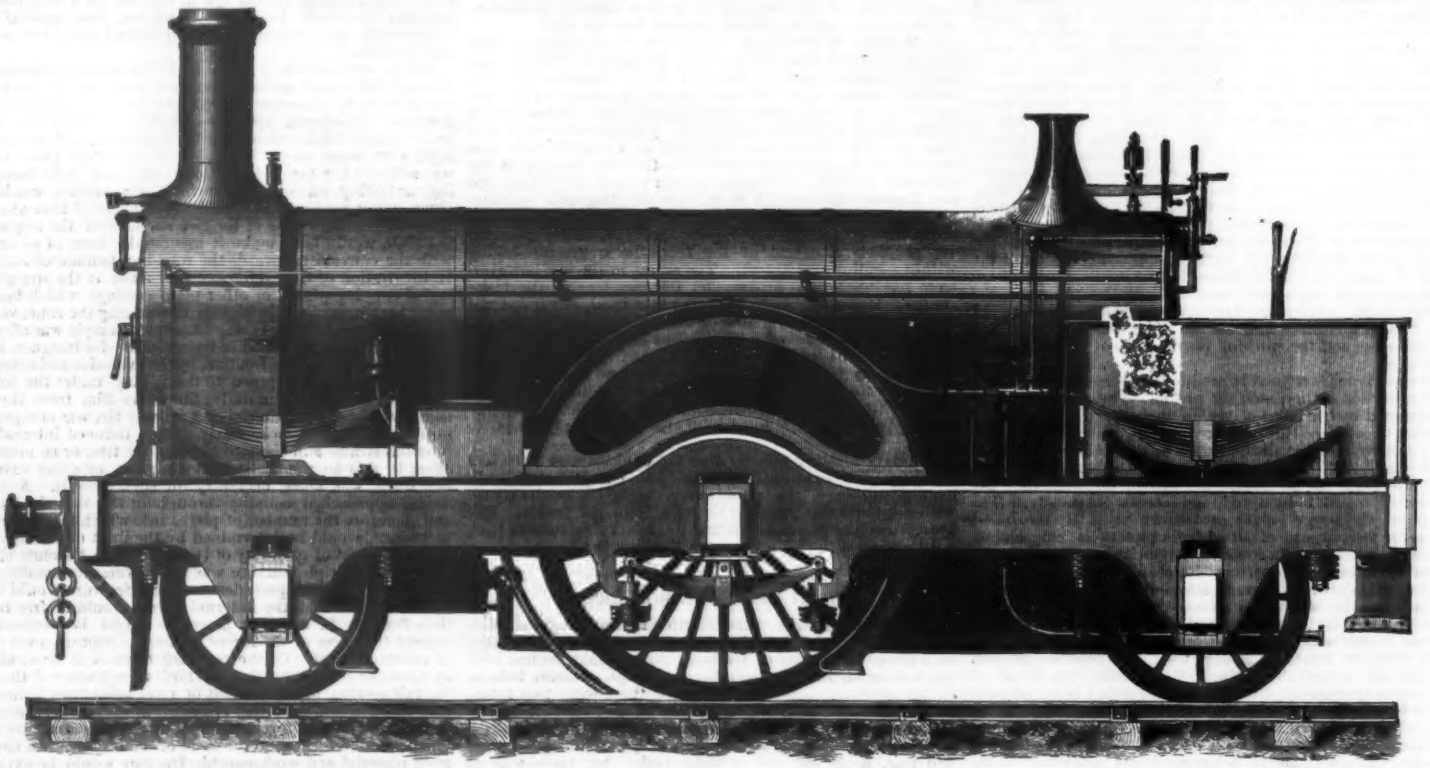
A WATER PROPELLED ROASTING JACK.

THE Duke of Westminster has recently had constructed for the kitchen of Eton Hall a roasting jack turned by water. The wheel is four feet in diameter, and five feet in breadth; it sets in motion six horizontal and four vertical spits, on which about a ton of meat can be cooked at the same time. But this is not so large as the spit called "Bir Nechin," in the banqueting hall of ancient Tara, which is described in an old Gaelic manuscript preserved at Trinity College, Dublin, which says that this jack was composed of iron and wood, and had "twice nine wheels on its axles, that it might turn the faster; and there were thirty spits out of it, and thirty spindles, and thirty hooks, and it was as rapid as the rapidity of a stream in turning; and thrice nine spits, and thrice nine cavities [pots], and one spit for roasting, and one wing used to set it in motion." The household of the monarch of Erin, for whom so large a jack was needed, numbered about a hundred souls, for whose daily meal two cows, two pigs, and two salted hogs were cooked.

EXPRESS ENGINES—GREAT WESTERN RAILWAY, LONDON, ENGLAND.

So much has been said lately concerning the engines used by the Great Western Railway Company in working their fast traffic, that our readers will, no doubt, be interested by some information concerning the latest type of express engine used on this railway. By the courtesy of Mr. Armstrong, locomotive superintendent of the line, we are enabled, says *The Engineer*, to illustrate the new express engines, of which several have just been turned out from the Swindon Works. An examination of these engines, and some experience of their powers with heavy trains, justify us in pronouncing them as among the very best engines of the kind ever designed. It will be seen from our drawing that they are extremely simple, and the symmetry of their proportions has been very carefully observed, without suffering beauty of form to detract from utility. It is just as easy, after all, to make locomotives handsome as ugly, when a designer possesses sufficient taste for the purpose, which is not always the case. The principle dimensions are as follows:

	Ft.	In.
Boiler:		
Length, Lowmoor iron	10	6
Diameter, inside	4	1 1/2
Thickness of plates	0	7/16
Do. of tube plate	0	5/8
Angle iron	4 1/2×3 1/2	
Diameter of rivets	0	3/4
Distance of centers	0	1 3/4
Number of Stays, 7; diameter	0	1
Chimney:		
Diameter, taper 1 ft. 4 in. to	1	6
Height of top from rail	12	10 1/2
Thickness of plate	0	1/8
Blast Pipe:		
Description—cast iron	—	
Diameter at top, inside	0	5 1/4
" bottom	1	5×9 1/4"
Height	3	0
Injectors, two No. 8	—	
Safety Valves:		
Description—brass, 1 lever, 1 lock	—	
Diameter	0	4
Centers of valves	0	5 1/4
Centers of levers, 3 1/16 in., 2 ft. 8 11/16 in.		
Cylinder:		
Diameter	1	6
Stroke	2	0
Distance of centers	2	6 1/2
Distance below boiler	1	4
Distance of centers of valve spindles	0	5 1/4
Diameter of " " "	0	1 1/2
From center of cyl. to center of valve spindle	1	
Number of belts in front flange, 14; diameter	0	7/8
Do. in back do., 8; diameter	0	7/8
Thickness of cylinder	0	1
Diameter of piston rod	0	3
Depth of piston	0	4
Description—cast iron	—	
Depth of packing ring	0	1/2
Nave:		
Diameter	1	5 1/4
Breadth at top / Breadth at center	7	1/2
Diameter of hole	0	8 1/4
Projection beyond outside of tire	0	1 3/4
Projection beyond inside of tire	*nil.*	
Front wheels:		
Diameter	4	0
Breadth of outside tire	0	5 1/4
Thickness of outside tire	0	2 3/4
Height of flange	0	1 1/16
Inside tire—breadth	0	4 1/4
" " thickness	0	2
Spokes—number, flat, 12	—	
" thickness at top	0	1 1/4
" thickness at bottom	0	1 3/4
Distance of wheels apart	4	5 1/4
Cone of wheel, 1 in 15	—	
Nave:		
Diameter	1	3
Breadth at top / Breadth at center		
Diameter of hole	0	7
Projection beyond outside of tire		1/16
Projection beyond inside of tire	0	1/16
Hind Wheels.		
Diameter; Breadth of outside tire; Thickness of outside tire	Same as leading wheel.	



EXPRESS PASSENGER ENGINES.—GREAT WESTERN RAILWAY, ENGLAND.

	Ft.	In.
Outside Fire box:		
Description—Lowmoor iron	—	
Length, outside	6	4
Breadth, "	4	0
Height above boiler—flush	—	
Depth below "	3	3 5/8
Thickness of plates	0	1/2
Diameter of rivets	0	3/4
Distance of centers	1	1 3/8
Number of stays, 2; gusset	—	
Distance of copper stays apart	0	4 1/4
Diameter	0	7/8
Inside Fire box:		
Description—Copper	—	
Length, outside	5	9 1/4
Breadth, "	3	6 1/4
From top of box to grate	5	9 1/4
From bottom of box to top of grate	0	8
Side water spaces / Front " " / Back " "	3 in. at top, 2 1/4 in. at bottom.	
Thickness of plates—Back plates, 9/16 in.; lapping do. 1/2 in.		
" of tube plate—3/4 in. at top, 1/2 in. at bottom		
Fire door	1	3×12"
Number of stays, 104; vertical stays, diam.	0	1 1/2
Number of bolts in each, —; diameter	—	
Number of fire bars, 44; distance apart	0	3/4
Diameter of rivets	0	3/4
Distance of centers	0	1 7/8
Area of fire grate, sq. ft	17	0
Superficial area of box, sq. ft	133	0
Diameter of steam pipe, inside	0	4 1/4
Tubes:		
Description—iron	—	
Length	10	11 1/4
Diameter outside	0	1 3/4
Distance of centers, 2 1/4 in. vertical, 2 in. horizontal.		
Number, 15 wire gauge	—	
Number, 250	—	
Sectional area, sq. ft	1145·5	0
Superficial area, sq. ft	1278·5	0
Total Heating Surface—Smoke box:		
Description—circular	—	
Length, outside	2	7 3/4
Breadth, outside	5	0
Depth below boiler	0	4 1/4
Thickness of plate	0	1/2
Diameter of rivets	0	3/4
Distance of centers	0	3
Distance between inside of ports	2	2
" " " of covers	1	8
Ports:		
Breadth	—	
Length of steam	0	1 3/4 ×16
Length of exhaust	0	3 1/4 ×16
Thickness of bridge	0	1
Slides:		
Travel	0	4 1/4
Lead—fore gear, 7/16 in.; back gear, 9/16 in.		
Steam overlap	0	1 1/8
Eduction overlap	*nil.*	
From face of slide to center of spindle	0	7/8
Eccentrics:		
Description—cast iron	—	
Throw	0	3 1/16
Diameter	1	2 5/8
Number 4	—	
Breadth	0	3 1/4
Diam. of weigh bar for lifting eccentric rod	0	3 1/4
Regulator:		
Description—cast iron	—	
Steam way—two ports	6 1/4×1	
Motion bars:		
Length inside	3	8 1/4
Breadth	0	5
Distance apart	0	10
Depth at center	0	2 1/4
" at ends	0	1 3/4
Length of block	1	2
Crosshead:		
Diameter of pin for blocks	0	3 1/4
Diameter of boss for piston rod	0	2 3/4
Diameter of socket for connecting rod	0	3
Length of " " " "	0	3 1/8
Cross section of arms	—	
Driving wheels:		
Diameter	7	0
Breadth of outside tire	0	5 1/4
Thickness of outside tire	0	2 3/4
Height of flange	0	1 1/16
Inside tire—breadth	0	4 1/4
" " thickness	0	2
Spokes—flat, 4 1/4 in. at boss; 3 1/4 in. at rim.		
Number of spokes, 24	—	
Thickness at top	0	1 1/2
" at bottom	0	1 3/4
Distance of wheels apart	4	5 1/4
Cone of wheel, 1 in 15	—	
Height of flange; Inside tire—breadth; " " thickness; Spokes—number; " thickness at top; " " at bottom; Distance of wheels apart; Cone of wheel	Same as leading wheel.	
Nave:		
Diameter; Breadth at top; Breadth at center; Diameter of hole	Same as leading wheel.	
Projection beyond outside of tire		
Projection beyond inside of tire		
Distance of Centers of Wheels:		
Center wheels from front wheels	8	6
Center wheels from hind wheels	9	0
Driving Axle:		
Front fire box	2	1 3/8
Distance below boiler	1	4
Diameter in middle	0	6 3/4
Diameter where wheels are on	0	8 1/4
Diameter of crank pin	0	7 1/4
Length of crank pin	0	4
Diameter of inside bearing	0	7
Length of " "	0	6
Distance of centers of "	4	1/2
Diameter of outside bearings	0	6
Length of outside bearings	0	9
Distance of centers of bearings	6	6
Cross section of crank arm—top, 1: 1; bottom	10×4	
Outside Cranks:		
Length	—	
Diameter of pin	—	
Length of bearing	—	
Diameter of boss for pin	—	
Plain Axle Front Wheels:		
Diameter in middle	0	6
Diameter where wheels are on	0	7
Diameter of bearing	0	5
Length of bearing	0	10
Distance of center of bearings	6	6
Plain Axle Hind Wheels:		
Diameter in middle; Diameter where wheels are on; Diameter of bearing; Length of bearing	Same as front wheels.	

	ft.	in.
Springs for Driving Axle:		
Length unloaded, centers	2	5¼
Breadth	0	4
No. of plates, 12; 11⅝ in. and 1¼ in.		
Depth	0	4⅜
Description—laminated		—
Springs for Front Axle:		
Length unloaded, centers	4	4¼
Breadth	0	4
Number of plates, 17; 9⅝ in. and 8⅝ in.		
Depth	0	8⅝
Description—laminated		—
Springs for Hind Axle:		
Length unloaded, centers	4	4½
Breadth	0	4
Number of plates, 15; 8⅝ in. and 7⅝ in.		
Depth	0	7⅝
Description—laminated		—
Frame:		
Extreme length	25	0
Extreme breadth	6	9
Dis. of cents. of frame—inside, 4ft. ¼ in.; out	6	6
Depth	1	3
Thickness—inside, ⅞ in.; outside	0	⅝
From top of frame to center of cylinder	0	7¼
Description—single plates B.B. Staffordshire		—
Thickness of drag plates	0	⅝
Diameter of pin	0	2¼
Buffers:		
Height from rail	3	4
Distance of centers	5	10
Suction Pipes:		
Description—hose		—
Height from rail	1	3
Distance of centers	3	9
Diameter of water way	0	1⅜
Weight of eng. in work'g trim, 32 tons 10 cwt.		
" " empty, 28 tons 10 cwt.		
Consumption of coke per mile		—

LIGHT WEIGHT FREIGHT CARS.

To the Editor of the Scientific American.

I NOTICED an article in the SUPPLEMENT of January 13 in relation to light weight specimen freight cars, and quoting especially one built by C. A. Smith, of Erie Railway, in 1872. Perhaps it would interest railway men to know that in 1874 I built for the Housatonic Railroad a platform freight car 28 feet long, with iron trucks, which weighed, complete, 13,000 lbs., and which carried safely from Bridgeport to Pittsfield and back 30 gross tons of pig iron, and when I was over that road one year ago last June I saw the same car in apparently as good order as ever. This remarkable load was taken over the road by order of the president, for the purpose of testing the car and also the bridges, and I now have a letter from him highly recommending the peculiar form of trucks, etc., which were used under that car. There is not a doubt in my mind but that from 3,000 to 5,000 lbs. is carried uselessly on each and every ordinary freight car now running on railroads of common gauges. G. G. H.

BRISTOL STATION, Ill.

THE ORDINARY CAR LOAD.

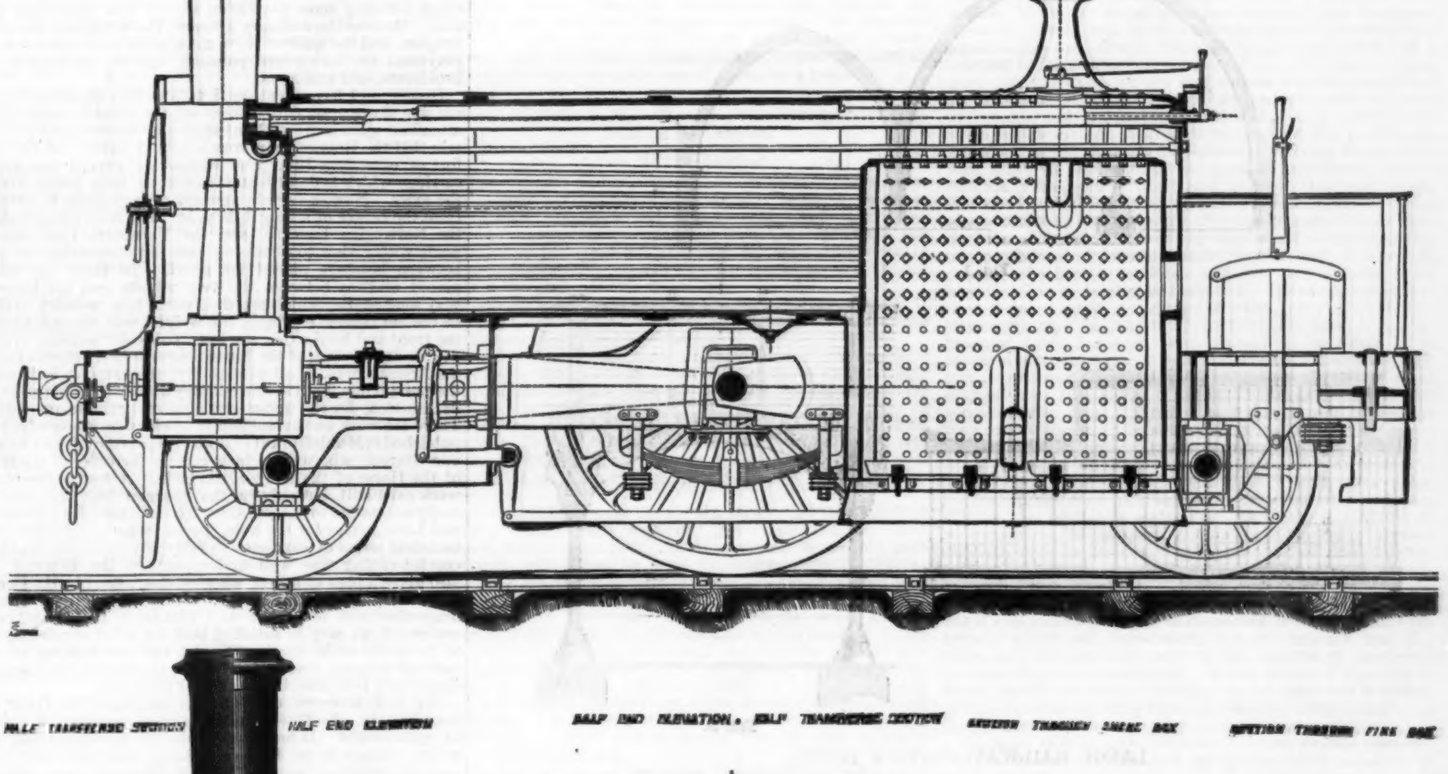
NOMINALLY a car load is 20,000 pounds. It is also 70 barrels of salt, 70 of lime, 90 of flour, 60 of whiskey, 200 sacks of flour, 6 cords of soft wood, 18 to 20 head of cattle, 50 to 60 head of hogs, 80 to 100 head of sheep, 9,000 feet of solid boards, 17,000 feet of siding, 13,000 feet of flooring, 40,000 shingles, one half less hard lumber, one fourth less of green lumber, one tenth of joists, scantling, and all other large timbers, 340 bushels of wheat, 400 of corn, 680 of oats, 400 of barley, 360 of flaxseed, 360 of apples, 430 of Irish potatoes, 360 of sweet potatoes, 1,000 bushels of bran.

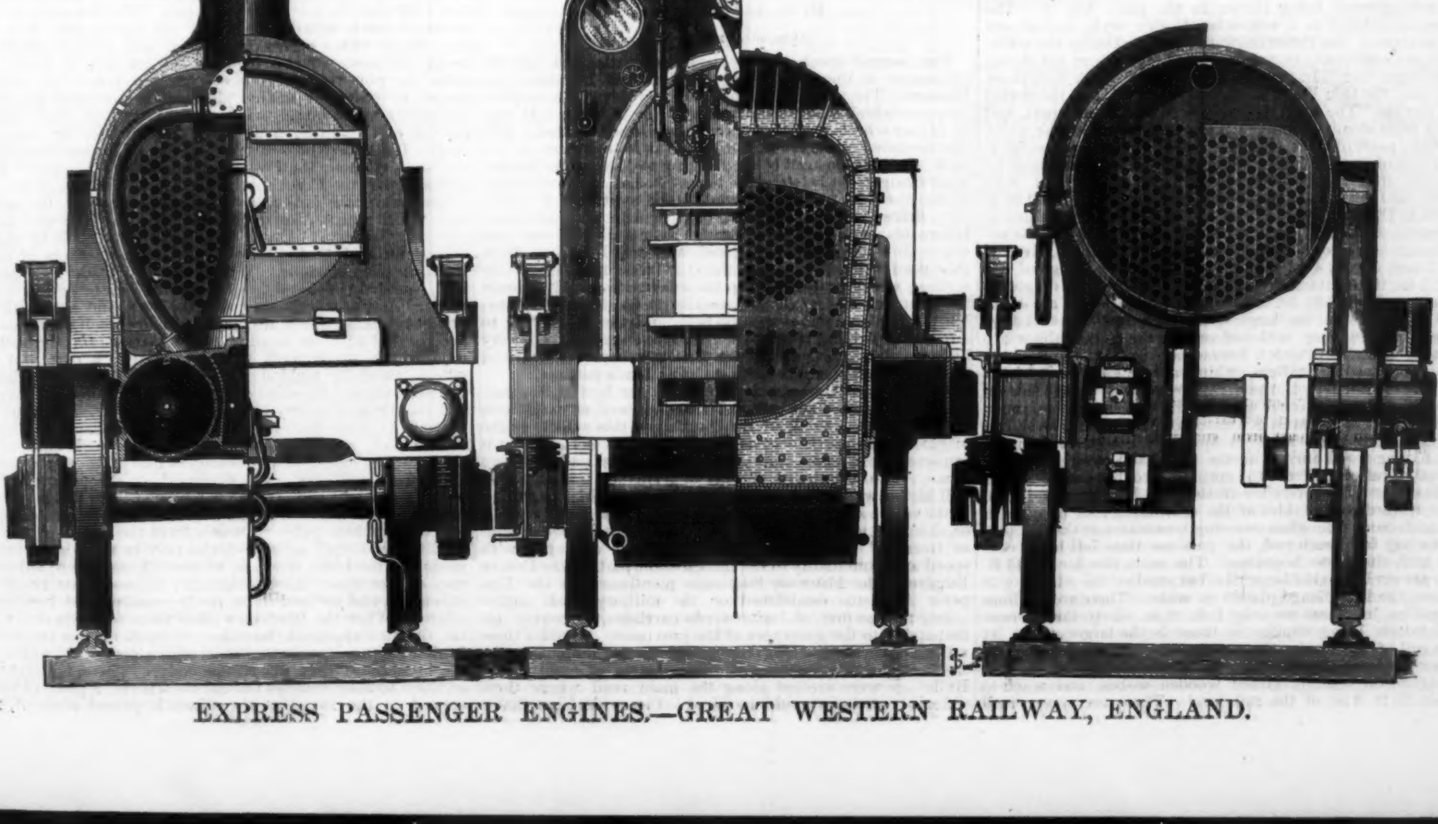
THE BHOR INCLINE.

THE entire length of the Bhor Incline, India, is a little less than sixteen miles. The whole ascent is nearly 19,000 feet. The steepest grade is 1 in 37 and the lowest 1 in 52. There are eight stone bridges of more than fifty arches, and twenty-five tunnels of an aggregate length of two miles and a quarter. In some places the retaining wall, at the top of which runs the road, is begun one hundred feet down the side of the mountain. The survey took four years, and the construction about seven and a half years more. The total cost was upwards of five and a half millions of dollars.

THE ST. GOTHERD TUNNEL.

THE great St. Gotherd tunnel through the Alps in Switzerland is now steadily progressing. The length when completed will be thirteen miles. The through traffic between Western Europe and the Mediterranean through this tunnel is expected to be very great.





EXPRESS PASSENGER ENGINES.—GREAT WESTERN RAILWAY, ENGLAND.

RAILWAY STATION ROOFS.

Messrs. Andrew Handyside & Co., of Derby and London, are at present engaged in making the iron roofs of four railway stations, all of some importance and interest. At Glasgow, for the Union Railway at the new St. Enoch's square station, the roof is a large single span of 198 ft. and 518 ft. long, of somewhat similar construction to that of St. Pancras, London, which is 240 ft. span and 689 ft. long. The main ribs in the Glasgow roof weigh 37 tons each, and the total weight of iron work is 1,460 tons. Mr. Blair (since deceased) was the engineer under whom the construction of this station was commenced. Messrs. Handyside & Co. expect to finish the iron work soon after Christmas, and the station will be completed during the summer. At Manchester the three railway companies, the Midland, the Great Northern, and the Manchester, Sheffield, and Lincolnshire, are about to build a large joint station under the superintendence of Mr. Charles Sacré, the engineer of the last named company, and have ordered from Messrs. Handyside & Co. the iron roof. This roof again is of the same kind as at St. Pancras, but larger than at Glasgow, having a span of 210 ft.; and a length of 550 ft., the weight of iron work being no less than 2,400 tons. This station is to be completed in 1878. At Middlesborough a new station is being constructed for the North Eastern Railway Company, from the designs of Mr. W. Peachey, architect to the company, and the roof, which Messrs. Handyside & Co. have been making at Derby, is now nearly all erected by them at the site.

In Mr. Ewing Matheson's "Works in Iron" we have the following particulars of this roof:

"The station is 309 ft. long, covered for 180 ft. of that length by two spans, one of 74 ft. (in the clear), and one of 43 ft. 2 in., and for the remainder by the larger span only, this arrangement being shown in the plan, Fig. 2. The arches are pointed in a somewhat Gothic style, and are not tied or trussed, the thrust outwards being taken by the walls, which are sufficiently buttressed by outer buildings not shown in the engraving. In the plan, Fig. 2, the thick lines show main ribs, the thin lines intermediate rafters, and the dotted lines purlins. The main ribs are placed 20 ft. 2 in. apart, and spring from stone columns or pilasters attached to the walls, and from pairs of iron columns where the two spans meet. The pairs of iron columns are connected longitudinally by wrought iron box girders pierced and ornamented with pateræ, and with ornamental cast iron spandrils, filled in as shown in Fig. 3. The ribs for the 76 ft. span are formed as triangulated ribs 2 ft. deep, with flanges 12 in. wide, the upper flange being composed of two plates ⅜ in. thick, rivetted to a T iron 5 in. x 4 in. x ½ in., and the lower flange of one plate ⅜ in. thick attached to a similar T iron. The diagonals are channel bars 2½ in. x 1½ in. x ½ in. There are eight lines of purlins in the large span, each made as a lattice girder 1 ft. 6 in. deep, widened out at the ends to the width of the arched ribs which it intersects. Upon the purlins are placed intermediate rafters, which are single T bars 4 in. x 4 in. x ½ in., the feet of these rafters resting at one side on the wall, and on the other upon the girders between columns. At the crown of the arch is a raised ventilating roof as shown in Fig. 1, formed of cast iron spandrils placed in the main ribs, having wood louvres at the sides, and covered by slate on timber rafters. From the springing to the second line of purlins the roof is covered with slates on boarding, and from these upwards to the sides of the ventilating roof by glass in iron sash bars. The glass covering terminates at the distance of one bay from each end, the portions thus left being covered with zinc upon boarding. The main ribs for the 43 ft. span are similar to the large ribs, but smaller, the rib being 18 in. deep, and the flange plate 9 in. wide. There are six lines of purlins, but these are only 1 ft. 2 in. deep, the intermediate rafters being similar to those in the larger span. At each end of the station two main ribs are placed close together to carry the screen. These screens are formed of wrought iron framing glazed wooden sashes, and reach to within 15 ft. 3 in. of the rail level. There are some small side roofs, and other minor structures, but exclusive of these, the weight of the iron work described above is as follows:

	Tons.
In main ribs for large span	155
In purlins	55
In intermediate rafters for large span	20
In ventilator and other iron work	26
In main ribs for small span	39
In purlins	20
In intermediate rafters for small span	9
In box girders between columns	10
In other iron work	5
Eight pairs of cast iron columns	20
Cast iron spandrils between columns and longitudinal stays between principals	52

The gutters are of lead.

A new terminal station is being constructed at Cape Town, South Africa, under the superintendence of Mr. R. E. Brounger, engineer to the railway company there. The same type of arched roof as at St. Pancras has been adopted, but on a small scale, as the span is but 77 ft. and the length 256 ft. 9 in., divided into 13 bays of 19 ft. 9 in. In this case a few manufacturers were asked to submit designs to Mr. C. H. Gregory, who acts for the railway company in England. The design of Messrs. Handyside & Co. was accepted, they having reproduced, with certain modifications, the roof over the Drill Hall at Derby, which they erected in 1870. The Cape Town roof will be covered by zinc on boarding, except at a raised ventilating roof in center, which will be covered with glass. The iron work will weigh nearly 200 tons.—*Engineering.*

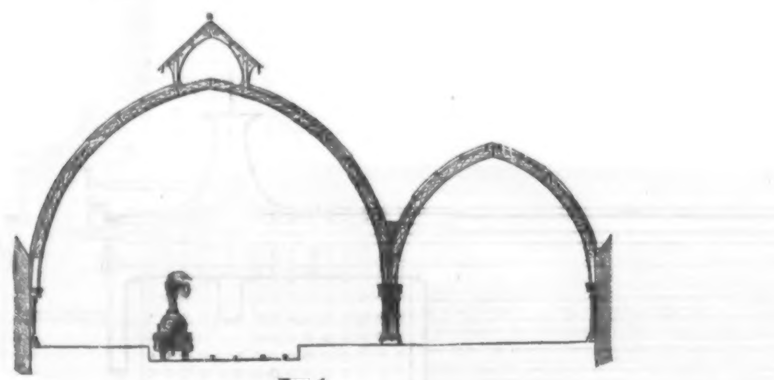


Fig. 1.

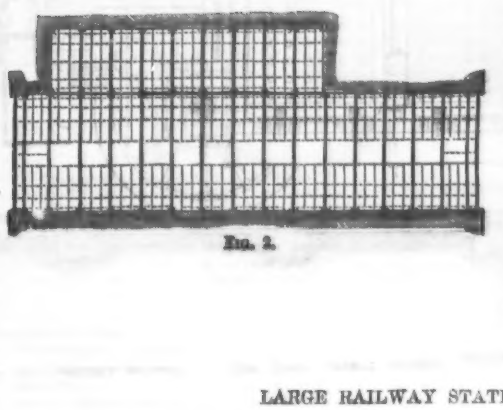


Fig. 2.

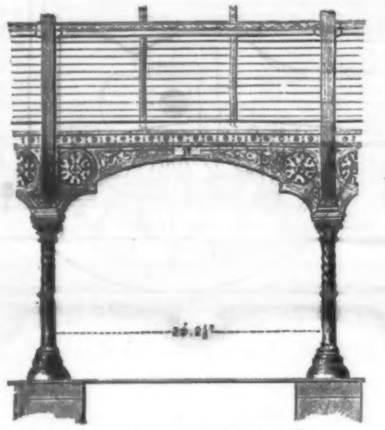


Fig. 3.

LARGE RAILWAY STATION ROOFS.

THE HISTORY OF THE ART OF COACH-BUILDING.

By G. A. Thrupp, Esq.

[Concluded from p. 902.]

The second epoch of the history of carriages I take to commence at the invasion of Belgium and Britain by the Romans. The ancient Britons had used a car for warlike purposes which was evidently new to the Romans. It was on higher wheels than their cars, it was open in front, and was ascended in the front, instead of, as in their cars, at the back; the pole, instead of sloping up to the horses' necks, went straight out between the horses' bodies, and was broad, so that the driver of the car could stand on it, and if necessary, drive from the end of the pole, or leap out and stand before his horses. It was larger than a Roman car, and above all it possessed a seat, and was called *essedum* from this peculiarity. At times this car was furnished with scythes, which projected from the axletree ends. No doubt the same or a similar car was used by the Gauls and Belgians; but the British *essedum* was the best; and Cicero, writing to a friend in Britain, remarks "that there appeared to be very little worth bringing away from Britain except the chariots, of which he wished his friend to bring him a pattern."

When Cassibelaunus was taken prisoner by the Romans, they also captured 600 cars and 4,000 *essedarii*, or car drivers and warriors. I think we may look upon this vehicle as the origin of the curricle of later years. It is certain that it attracted great notice among the Romans, and under its own name, *essedum*, and with another of a smaller size and with still higher wheels, called *cisium*, became the chief and most rapid vehicles upon the public roads, whether in Italy itself, or along the military roads already made into France, Spain, or Germany. Despatches and letters were conveyed with speed and punctuality to the more distant parts of the Roman Empire. The historian Suetonius mentions that the Emperor Augustus established on the military roads active young men at first, and afterwards carriages, to convey his despatches to the governors of the provinces. Besides these rapid conveyances along the public roads, there was the *rheda*, a slow sort of wagon drawn by six or eight mules. Buildings were erected along the main road where these different carriages could be hired. Cicero declares that a message was sent 56 miles in a *cisium* in 10 hours. On a monumental column at Ingel, near Treves, is the representation of two persons riding in a *cisium* with one horse. The vehicle is very much like a gig.

Under the Emperors of Rome, the number of kinds and shapes of vehicles increased; but from the vague manner in which the writers of the period speak of them, it is difficult to enter into minute descriptions. The height of the wheels increased. At the capital of Rome, the Emperor, Marcus Aurelius, is represented in a car of triumph, the wheels of which are as high as the backs of the horses. Sir William Gell, in his work on the ancient city of Pompeii, which was destroyed in the year A. D. 79, mentions that three wheels had been dug out of the ruins in his day—very much like our modern wheels—a little dished, and 4 ft. 3 in. high, with 10 spokes, rather thicker at each end than in the middle. Sir W. Gell also gives a well known picture of a cart used for conveyance of wine in a huge skin or leathern bag; it is a four wheeled cart, with an arch in the centre for the front wheel to turn under. The pole in this painting appears to end in a fork, and to be attached to the axle bed. As the wealth of the Romans increased, so did their desire to use comfortable and highly decorated carriages. For many years what are called "sumptuary laws" existed, which regulated each citizen's dress, furniture, and ornaments, according to his rank and consequence, and these laws restrained the decorations upon private carriages.

The Emperor Alexander Severus, however, issued a decree, "that anyone might decorate his car as he pleased;" and the number of vehicles in use rapidly increased. We find upon monuments many different shaped cars of the time of the Emperors, chiefly processional cars, lofty and highly ornamented, evidently adorned with embossed and chased work in metal, rich carvings, drapery and cushions. On the columns of Theodosius, at Constantinople, are some specially handsome cars on two and on four wheels, with door-like openings in the sides of a square shape. On the arch of Constantine, at Rome, are several cars. Sufficient evidence, however, exists, that for nearly 500 years, during the reign of the different Emperors of Rome, the art of coach building must have been a good and important business. Besides the ordinary artisans, the woodmen, the wheelwrights, and the smiths, there must have been plenty of employment for the carvers, painters, chasers, embossers, embroiderers, and trimmers.

Homer, as I have mentioned, tells us that the seat of Juno's car was slung upon cords, to lessen the vibration and jolting attendant upon a car without spring or braces; and it is certain that the Roman Emperors were not better off for comfort or ease than Juno was, unless we except one sort of carriage which is described as borne on long poles, fixed to the axles. Now, a certain amount of spring can be obtained from the centre of a long light pole. The Neapolitan Calesso, the Norwegian Carriole, and the Yarmouth Cart, were all made with a view to obtaining ease by suspension on poles between bearings placed far apart. In these the seat is placed midway between the two wheels and the horse, on very long shafts, which are thus made into wooden springs. In the old Roman carriages the weight was carried between the front and hind axles, on long poles or wooden springs. The under carriage of the latter four wheeled vehicles used by the Romans was, in all probability, the same as is in use in the present day, both in this country and on the Continent, and in America, for the under carriages of agricultural wagons. There is a work on this subject of ancient carriages which was published in Munich in 1817; it was prepared by John Christian von Ginzrot, who was an inspector in the office of the Master of the Horse of the King of Bavaria. A few copies of this work exist still, but only in the German language, and not easily accessible to the public. This author gives the Greek and Latin names for the pole, perch, wheel plate, and other technical terms of carriages so fully as to leave no doubt that coach-building was well understood by the Romans. He also gives a plan of a four wheeled dray, used by the Romans for conveying casks of wine, which is identical with the drays used now in Vienna and Munich. If his authorities are sound, we may be satisfied that the art of coach-building, as far as the under carriage works, and the making of agricultural wagons, was as forward in the days of the Cæsars of Rome as it is to this day in central Germany.

We will, however, quit ancient carriages for those now used in Asia. In Hindostan are a great number of vehicles of native build It has been frequently remarked that there is little change in the Eastern fashions, that tools and workmen are precisely as they were a thousand years ago, and the work they produce is precisely the same. In examining, therefore, what is done now by Indian coach builders, we are probably noticing carriages of a similar, if not identical, sort with those in use 3,000 years ago. The commonest cart in Hindostan is called "hackery" by Europeans; it is on two wheels with a high axletree bed, and a long platform, frequently made of two bamboos, which join in front and form the pole, to which two oxen are yoked; the whole length is united by smaller pieces of bamboo tied together, not nailed. In France, two hundred years ago, there was a similar cart, but the main beams terminated in front in shafts; in neither the cart of India nor of France were there any sides or ends; the French cart is called "haquet;" it is probable that the French, who were in India, as well as ourselves, may have given the term "hackery" to the native cart, which was so like their own. The native name, however, is "Gharry." Other carts have sides made by stakes driven into side beams; the wheels are sometimes of solid wood, or even of stone. Wheels are also made by a plank with rounded ends, and two felloes fitted on to complete the circle. Again, wheels are made like ours, and also with six or eight spokes, which are placed in pairs, each pair close to and parallel with one another. If a carriage for the rich is required, the under work are like those of a cart, but the pole is carefully padded and ornamented with handsome cloths or velvet; the sides of the body are railed or carved, and the top is of a very ornamental character, similar to the howdah of state that is placed on an elephant. It has a domed roof, supported upon four pillars, with curtains to the back and sides. The passengers ride cross-legged under the dome, on pillows. The drivers sit on the pole, which is broad at the butt end, and he is screened from the heat by a cloth which is fastened to the dome roof and supported upon two stakes which point outwards from the body. A variety of different shaped native vehicles may be seen in elaborate models in the India Museum, at South Kensington; although they do not show much originality in design or beauty of execution, and are said to be really creaking and lumbering affairs. When the Hindoos wished for a four wheeled vehicle, the plan appears to have been to hook on one two-wheel behind another, connecting them with a perch bolt, and upon the hindermost they placed the body. There is a singular addition to their vehicles outside the wheels; a piece of wood curved to the shape of the wheel is placed above it, fre-

quently supported by two straight uprights from the end of the axletree outside the wheel; this acts as a wing or guard to keep anyone from falling out of the vehicle, and also the dress of the passengers from becoming entangled in the wheel. In addition, a long bar of wood, rather longer than the diameter of the wheel, curved in the shape called "Cupid's bow," is fastened to the axletree, the linchpin being outside of it, and the ends of the bar tied to the ends of the wing by cords. I imagine it to be placed in order to be a safeguard for the people in crowded streets, who might be pushed by the throng against the wheel. It will be seen in many of the models, and I have seen it also in ancient drawings of India and Persian vehicles. Many of the carts, which are designed to carry heavy loads, have a curved rest from 20 in. to 30 in. long attached to the lower side of the front end of the pole; this serves not only as a prop whilst the vehicle is being loaded, but, should the oxen trip and fall, it supports the cart, and prevents the load, yoke, and harness from weighing down the poor animals as they struggle to recover themselves. In England we have very few of these humane contrivances; we have, however, short rests to prop up a hansom cab when not at work. In India there are several huge unwieldy structures on wheels called "idol cars;" the name of the car of Juggernaut must be familiar to many. The wheels of some of these are enormous blocks of stone shaped and drilled for the work. In the Indian Museum there is a photograph of an idol car from South India, in the district of Chamoondee and the province of Mysore, which deserves examination. The car appears well proportioned, and the ornamental carvings are beautiful in design, and would bear comparison with most European work.

The *Hecca* or *Heka* is a one horse native car, resembling an Irish car; it consists of a tray for the body, fixed above the wheels on the shafts, and has a canopy roof; the driver sits on the front edge of the tray, and the passenger cross-legged behind him. The *Shampony* is the usual vehicle for women, which resembles the former, but it is larger; the wheels are outside the body, and it is drawn by two bullocks; the canopy roof is furnished with curtains that are drawn all round, and the driver sits on the pole in front of the body. All these native vehicles have wooden axles, which, until recently, I am told, were used without grease, from the prejudices of the people forbidding them to use animal fat. Some used olive oil or soap, but in most large towns there are now regulations obliging the natives to use some substance to avoid the noise and creaking of the dry axles. The commonest carriages in Central India are called "Tongas," but the universal native word for a vehicle is "Gharry." In Calcutta are several coach-builders of repute, who employ large numbers of native workmen; Messrs. Dyke employ 600; Messrs. Stewart & Co., 400, and Messrs. Eastman, 300. The men are chiefly Hindoos, and are clever and industrious, but have a singular habit of sitting down at their work. The laborers, who have to use grease, are all Mahommedans. The wages vary from sixpence to two shillings per day.

A representation of a primitive vehicle, which was in the use of Hungary not very long ago, is given by Von Ginzrot as representing the Roman *rhedum*. It is very curious, and just such a primitive affair as might be made in any country. The body is a disguised wagon; the tilt top has two leather flaps, to fall over the doorways; the panels are of wicker work, such as was in common use for carriages both in Greece and Italy; and of such a character we may suppose the wagons were which were used by the many wandering tribes that, in the times of the Roman empire, poured out of Asia and Russia, and invaded Germany, Gaul, and Italy. In the history of Julius Cæsar's wars in Gaul, we are told of the large number of wagons which the savage wandering tribes possessed.

Another primitive vehicle is the Turkish "Araba," used for the conveyance of women. The lattice work admits air without too much light. The singular wing-guards over the wheels identify this "Araba" as being derived from the same source as the carriages of Persia and Hindostan. These vehicles have been superseded in many parts of Turkey, Asia, and Egypt by carriages sent from the West of Europe.

In 1860 a carriage was made for one of the ladies of the Sultan's harem, which consisted of silver as far as possible. It cost, it is said, 2,000,000 Turkish piastres, about £15,000; a very expensive present for the ruler of Turkey to make to one out of many wives.

To speak of one more primitive carriage. Dr. Edgeworth describes some cars which were in use in his time (that is in 1800) in Ireland, as the common vehicles of the country. They were composed of shafts with cross bars; two low wheels of solid wood were wedged on to the axletree, so as to form one piece, like a railway axle and wheels; they were nearer together than the shafts, and ran inside the shafts; the axle projected beyond the wheels, and moved in sockets beneath the shafts. These cars, Dr. Edgeworth says, "cost only four guineas, including painting; they would follow a horse anywhere, they could scarcely be overturned even with bulky loads, they were light and easily moved by hand, their repair was easy, and they lay so near the ground that they could be easily loaded and unloaded; the whole would turn in a very small compass." It is probable that these were the primitive cars of Ireland. The nearest approach to them in the present day are the costermongers' barrows. We have noticed how light and simple are these vehicles, and that a wretched pony or donkey will canter along with three or even four persons sitting upon them. They also resemble the Yarmouth cart, in which the wheels are inside the shafts; but then the difference is that the shafts of the Yarmouth carts are of great length, and the load is carried between the horse and the wheels instead of over the wheels, as is usual in a cart. In some parts of Wales cars are used of this construction, and are also supposed to be the primitive cars of that country; their wheels are solid. In Yarmouth this shape was adopted to suit the very narrow streets or alleys, which a cart made with the wheels outside the shafts could not traverse. The great length of the shafts is occasioned by the necessity of carrying a quantity of goods, such as barrels or sacks, which would tend to make the vehicle top heavy if piled up above the wheels.

The Irish jaunting car, as now built, is superior to the vehicle of 40 years ago. It was then on lower wheels, and being hung lower, the shafts pitched up in front, and the unfortunate passengers were huddled upon one another at every jolt in the road. The car was very light, a great benefit for the horse; it is easily turned and moved in a crowded thoroughfare, and is capable of conveying more luggage than might at first be supposed. The car is no doubt very cheap, and perhaps more Irish drivers are able to own their own cars than are the drivers of London cabs. Irishmen, perhaps, like the vehicle to which they are accustomed, but it will never become popular in this country.

The car, however, used in Cork, is still more uncomfortable: it is an inside car, that is, instead of sitting back to back, you sit face to face, and to most there is a hood or tilt; a very good vehicle no doubt for two persons at a slow pace, but with four persons at a trot it is the worst vehicle I had ever the misfortune to enter. If the Cork car was hung on higher wheels, and the shafts kept parallel to the ground, it would be a better vehicle; if, however, it cannot be balanced properly, it should be placed upon four wheels, like the inside cars of the North of England.

I will mention one more primitive vehicle—the cart with a tilt, with side windows, and a door behind, which is called a Coburg, and is used in the southwest of England; when on good springs, it is a very cheap and comfortable vehicle. In Belgium and Holland it is much used, and is usually built of a larger size than in England. It is, however, after all, rather like a bathing machine on wheels. It is to be found pictured in our earliest illustrations of vehicles in old English illuminated manuscripts, differing from the modern Coburg only in the want of a door and springs.

In reviewing what I have laid before you as to ancient carriages, I would say, that any one who desires to learn more about them can do so in the pages of the *London Carriage Builders' Art Journal* for 1859 and 1860, which appears to contain much of the information given by the German work of Von Ginzrot. It is interesting to observe the character of the different people illustrated in their carriages. The Egyptians, with all their learning and skill, appear to have made no change during centuries of experience; as at the beginning, so at the end, the kings stand by the charioteers, or hold the reins themselves. The Persians and Hindoos introduced luxurious improvements, and in lofty vehicles elevated the nobles above the heads of the people, and secluded their women in curtained carriages. The Greeks introduced no new vehicles, but perfected so successfully the useful wagon, that their model is still seen throughout Europe, without change of principle or structure. The Romans, on the other hand, in their career of conquest, gathered from every nation what was good, and, wherever possible, improved upon it—from Greece, the wagons; from Persia, the *harmamaxa* and elevated triumphal cars; and from Hungary, the *rheda*. We may well add that the genius of the Roman nation speaks through Cicero, when he wrote, "I hear that in Britain are most excellent chariots; bring me one of them for a pattern."

THE CONSTRUCTION AND PRESERVATION OF PLATE-HOLDERS.

By W. T. Bowers.

Most manufacturers of plate-holders deem it necessary to put in glass corners, silver wire, or something of that sort, for plates to rest upon, and they seem to think that it will not do for the plate to touch the holder, except at the corners. This is a great mistake, and the sooner they can be induced to discard glass and all other contrivances in the corners of the plate-holders, the better.

There should simply be a ledge of wood for the plate to rest upon, extending all the way round the plate-holder, just as they are made for ferrotype plates

I know that it has been objected that, if the negative touches the holder except at the corners, there will be danger of impurities flowing from the edge of the plate on to the surface, and producing stains. But such is not the case; on the contrary, the capillary attraction prevents the free solution from flowing from the edge of the plate, and there will be less trouble from that source than when the plate rests only at the corners. From long experience I know this to be true.

As little glue as possible should be used by the maker in putting plate-holders together. No varnish of any kind should be put upon them, but they should be treated with beeswax, which may be done by heating them by holding them to a hot stove, or putting them in a hot oven, and then rubbing them with the wax. Continue to rub the wax on to every part of the holder and slide till the wood absorbs enough to fill the pores. It would be a good method to put the holders into a dish of hot wax, and let them soak if you have plenty of wax; but with large holders this plan would hardly be practicable. It is something of a job to properly wax a set of plate-holders, but when once done they will last a lifetime. I have them that have been in constant use for a dozen years or more, and apparently they are just as sound and good as when new.

Beeswax is one of the most indestructible substances known. Silver solutions have no more effect upon it than upon glass; it is proof against the action of nearly all the chemicals used by photographers. It has been used, and its value understood, by many photographers for years, but I find that there are many who do not use it, and who do not seem to know how valuable it is. They still continue to varnish their plate-holders in the old way with shellac, which is worse than nothing, or use them till they fall to pieces, with no protection at all. To such I would say, try the beeswax, and you will find that it *pays*.—*Philadelphia Photographer.*

NEW PROCESS FOR SILVERING GLASS.

By A. Laval, St. Louis, Mo.

In carrying out my invention I prepare the ingredients: I first take eighty grams of nitrate of silver (either lunar caustic or the crystallized salt), and dissolve it in ten ounces of water, preferably distilled or rain water. To this I add two ounces of alcohol and two ounces of aqua-ammonia. The ammonia is added to the solution drop by drop, until the precipitate at first formed is dissolved. The solution is then allowed to settle for three or four hours, when it is ready for use, and forms solution No. 1. I then take six ounces of water and dissolve in it twenty-four grams of nitrate of silver, and add to the same thirty grams of arsenite or tartrate of copper, and then add, drop by drop, sufficient aqua-ammonia to dissolve the precipitate of oxide of silver at first formed, and the arsenite or tartrate of copper, after which add two ounces of alcohol. I then make a separate solution of forty-eight grams of potassa in sixteen ounces of water. This last-mentioned solution is brought to a boiling temperature in an evaporating-dish, after which the solution of nitrate of silver and arsenite or tartrate of copper is added, drop by drop, to the boiling solution of potassa, and the boiling is continued for about an hour, or until a white film collects on the surface, after which it is allowed to cool and filter, when it is ready for use, and forms solution No. 2.

In depositing the alloy upon the glass, I take a suitable quantity of filtered water, preferably rain or distilled water, and add to it equal parts of solutions Nos. 1 and 2, and mix the whole thoroughly, and apply this solution in any convenient manner to the glass to be coated, and the deposition immediately commences, and is allowed to continue, say, for about ten minutes, until the metal in solution is entirely exhausted, when the glass will be covered with a coating of the alloy, having a brilliant reflecting surface adjoining the glass.

In order to increase the durability of the coating I prefer to deposit a second coating upon the first, which is done by repeating the operation before the first coating is dry, and after the coating is completed I generally cover the whole with a heavy coat of asphaltum varnish, although this is not absolutely necessary, as the metallic alloy is sufficiently hard to stand ordinary wear without it.

By the above-described process an alloy having all the qualities of hardness and durability of the ordinary alloys of copper and silver is deposited upon the glass, and the degree of hardness may be varied or modified by varying the proportions of the different ingredients employed. Other salts of copper besides the arsenite or tartrate may be employed in conjunction with the nitrate of silver.

FIREPROOF CONCRETE.

It is a remarkable fact, says the London *Architect*, that the 1st prize medal ever bestowed by the Royal Institute of British Architects was given for an essay on the subject of concrete. This was in 1835; and Mr. George Godwin was the winner of the honor. How far the subject has progressed since then, both in scientific intricacy and in public importance, some may find it hard to understand; whilst others may only wonder how it happens that, after forty years, we should still have settled so little about it.

At the base of the general question of the use of concrete as a "fire-resisting material" (this, by the way, is a new phrase, and a very good one, which was brought forward by the officials of the Metropolitan Board in their last—unsuccessful—Building Act Bill), there may be said to lie the striking but quite intelligible proposition of Captain Shaw that common plastering is one of the very best preservatives of what it may cover from the effect of the heat of a fire. Iron, whether cast or malleable, wherever it is exposed, is virtually helpless. Stone cracks to pieces. Timber of course is fuel. Brick, or in fact any other material that has passed through intense heat in its manufacture, is necessarily fireproof to the last, except when its comparative thickness is unequal to the mechanical shocks produced by the conflagration. If, therefore, we can find a material which shall be of the nature of plastering superficially, which shall enable us to dispense with exposed iron, which shall be a substitute for stone, which shall do away with timber, and which (although it has not passed through the process of burning in manufacture) shall be substantially as good as brickwork, and as effectually fireproof if only thick enough, it is very natural that we should look with hope to this material, as one which seems obviously to be capable of being brought to bear upon the taste of fire-resistance to any degree and in any form that the conditions of building construction may incidentally require. So far as the brick walls go, it is not easy to see how they can be improved upon. Partitions also may continue to be of brick. In respect of stairs, it is very likely that terra cotta may be considered preferable to everything else. Internal doors, however, seem already to be found to be better of concrete than of iron; although it is certainly difficult to get over the fact that they cannot after all be made without iron framework. But the floors and the roof still constitute the great difficulty; and this is simply because they must necessarily be supported at short intervals. Iron pillars and iron girders are not to be thought of; even if cased in armor of concrete, or whatever else, it would be impossible at present to believe in them. Brick piers probably furnish the most truly scientific way of meeting their part of the case; and in a warehouse, where mere lightness of appearance would be but an affectation, it is doubtful whether they can ever be improved upon, especially if Staffordshire bricks, for instance, be used, purpose-made. For the floors, supported by such pillars, probably concrete, if made of the best materials, might be enough without any aid from iron; but if iron cannot possibly be dispensed with, let it take the form of a diffused reticulation, and certainly not that of a series of joists, and so it may, by the exercise of ingenuity, be made capable of protection. Roofs, again, if regarded as floors, would be only a repetition of the same construction; and an external covering from the weather, composed of even timber-work and slating, need scarcely be objected to.

We have said enough, however, for our present purpose, which is to show that the task undertaken by the Council of the Institute is not to be disposed of easily; and we will only add the hope that the profession, in answering the appeal, as we may call it, of Parliament, will endeavor to do credit to its scientific character.

SULPHUR CONCRETE.

Mix together nineteen pounds sulphur and forty-two pounds pulverized stoneware and glass. This mixture is exposed to gentle heat until the sulphur melts, when the mass is stirred until it has become thoroughly homogeneous, and is then run into moulds and permitted to cool. When required for use, it is heated to 248° Fahrenheit, at which temperature it melts, and may be employed in the usual manner. At 230° Fahrenheit it becomes as hard as stone, and, it is said, preserves its solidity in boiling water, unites stone, is waterproof, resists acids.

BLACK BRICKS.

The black bricks used about Boston are colored by heating red hot, and dipping the exposed surface into a pan containing half an inch or so of melted coal tar. Soft bricks are the best. Hard bricks or hard spots prevent the tar from penetrating the surface, as it should do, to a depth of one sixteenth to one eighth of an inch, and the coating peels off.

The *American Architect* observes: This method, so far as we know, is the only one for coloring bricks after they come from the yard. It has not been in use long enough to test the durability of the result thoroughly. We have seen bricks treated in this way, which in three or four years lost their color decidedly by weathering; and others which retained it perfectly for as long a time. It is essential to its success that the bricks should be porous, and that they should be dipped very hot. On the other hand, if they are too hot, the distillation of the tar is likely to prevent its soaking into the substance of the brick. Successful coloring is a matter of experience, therefore. In some that we have seen broken, the tar had penetrated a sixteenth of an inch or more below the surface. There seems to be no reason why such bricks should not hold their color for a good many years; but all vegetable substances, we fancy, are likely ultimately to bleach.

LESSONS IN MECHANICAL DRAWING.

By Prof. C. W. MacCord.

SECOND SERIES, No. IV.

The "strap and end," as it is frequently called, of the link or connecting rod, shown in Fig. 20, is supposed to be made of wrought iron only; and such arrangements are frequently used where the power to be transmitted is not very great. But in many, if not most, cases it is desirable to introduce brasses, in which the pin turns, for the purpose of diminishing the friction.

The arrangement of the parts when this is done is shown in Fig. 24; the strap, gib, and key remain as in Fig. 20, but we have in addition two blocks of composition metal, the one marked *A* being known as the "butt brass," the one marked *B* as the "crown brass;" and these are shown separately in Figs. 25 and 26.

In drawing the former, the first line to be put down is the horizontal center line; on this any center *C* is taken, about which is described the semicircle, being the half of the bearing of the pin, the vertical center line being next drawn through *C*, on which are to be set off on each side, first, *f i*, the thickness of the brass on the side; then *i g*, the breadth of the flange. Next set off *a b*, the thickness *a b* of the brass on the horizontal center line (which is much greater than *f i*, because the pressure is mainly in the direction of the length, so that more brass is required there not only for strength but to allow for wear), and then *b c*, which is usually equal to *i g*. It will be all the better if, after marking the points *b* and *c*, we set off transversely *b d* = *Oi*, and *c k* = *C g*, also *b e* and *c l*, above the center line, as thus there need not be a single superfluous line in pencil. This relates to the front view only; but the student should construct all three views simultaneously, as by setting off the breadths in the top and end views first, the lengths in the former and the heights in the latter may be projected directly from the front view without repeating measurements or readjusting the T square and triangle. And what we have here specified in regard to this simple detail applies to the construction of drawings of all degrees of complication; it is but the reiteration of what has in substance been said already more than once, the general principle being to draw as many lines as possible at one adjustment of the instruments, which not only saves time but conduces to accuracy. Many draughtsmen fall into a habit of drawing one view at a time, and then are astonished to see another execute the same plans more expeditiously without working, either apparently or really, any more rapidly than they do.

In drawing the crown brass, Fig. 26, the order of proceeding is substantially the same; but the peculiarities of its form, in the example selected, require some explanation. The thickness *a b* of the body of this brass is usually the same as that of the other one; but a saving of metal is effected by cutting off the corners, as shown by the sloping dotted lines, *l e*, *m d*. And it may not be amiss here to tell how this slope is determined. If we suppose the pin to wear away the brass, the center *C* will move to the right; and if it should wear entirely through, so that *a* should reach *b*, the semicircumference of the pin would have the position shown in dotted lining. It is therefore clear that the lines *l e*, *m d*, should not pass inside this dotted semicircle, or at least they should not cut off more than a very small segment of it. This being attended to, neither the precise angle nor the precise length of the sloping lines is of material importance; but, for the convenience of the mechanics in the shop—the pattern-maker and the finisher—the distances *h l*, *d e*, should be definite of measurement, as so many quarters, eighths, or sixteenths of an inch. So also should be the distance *b c*, which is determined thus: the outline of the flange on that side being a semicircle whose radius is *C g*, its center, *o*, is so placed on the horizontal center line that the semicircular outline shall be very nearly tangent to circles described about *l* and *e*, with radius equal to *i g*. We say very nearly tangent; for we should have something of a flange at those angles, but yet it is not imperative that it should be precisely as great as *i g*. Usually it is better to make it a little less, since otherwise the flange would be excessively wide at *b c*, and also half way between *l* and *e*; but the distance *b c* should also be a definite one.

We have purposely said nothing about the proportion between the diameter and the length of the pin, or between the dimensions of the pin and those of the brasses; nor do we propose to say anything about that between the area of the neck of the connecting rod and that of the strap. But when the latter area is settled upon, there are some simple considerations in regard to the dimensions of the other parts of the arrangements which it is not out of place to give here.

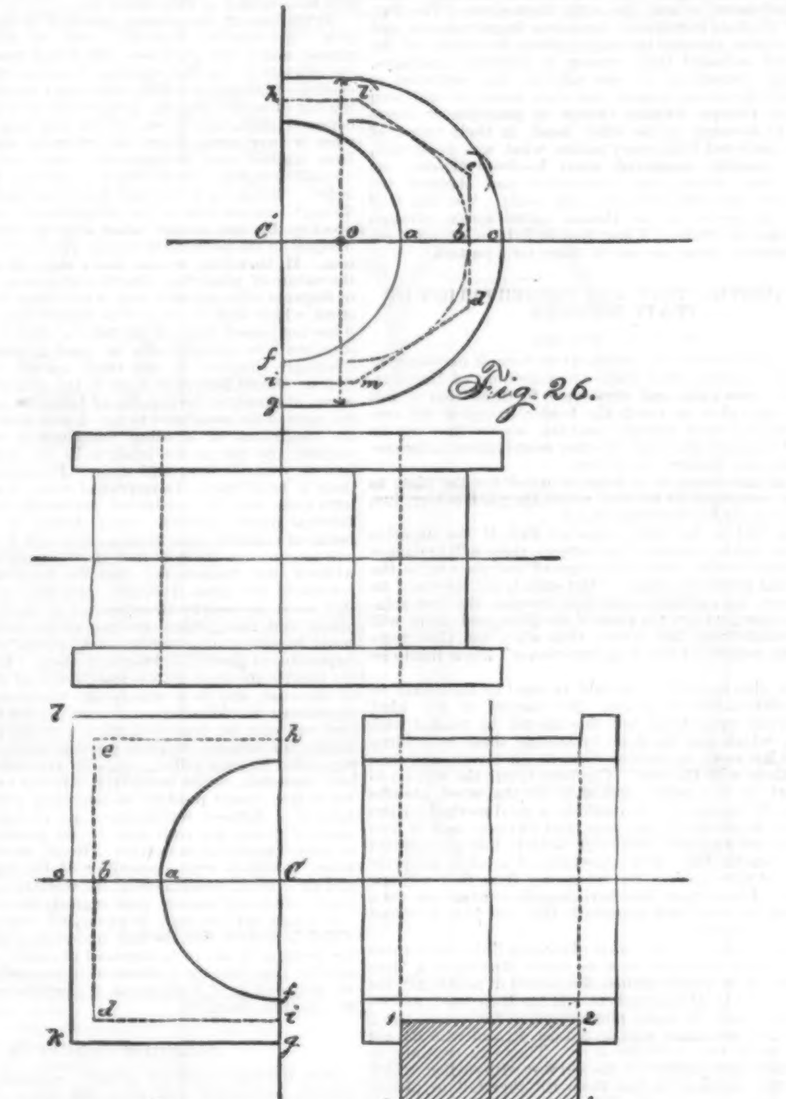


Fig. 25.

LESSONS IN MECHANICAL DRAWING.—SECOND SERIES, No. 4.

The strap is shown in the end view of Fig. 25, which is in reality a transverse section through the vertical center line of Fig. 24; its breadth, 1–2, being in this example equal to the diameter of the neck of the rod, whence the thickness, 1–4, is easily determined. This, however, is the least thickness; when the slot is cut through for the gib and key, the thickness of the strap must be increased until the lost area is restored. The thickness of the gib is usually one third of the breadth of the strap, or very nearly that, the thickness of the strap being consequently increased about one half.

Now, the connecting rod acts by pushing in one direction and pulling in the other. In pushing, the pressure is exerted directly against the brass by the butt end of the rod; but the pull is transmitted to the strap by the gib and key, the tendency being to shear them off both at top and bottom. Hence the sectional area of the two together, as seen in the top view of Fig. 24, should be equal to that of one side of the strap; dividing this area then by the assumed thickness, we ascertain the breadth, *e f*, Fig. 24. The distance, *c g*, of the back of the key from the brass is determined by the consideration that the key, when driven down, tends to split or drive out a piece, of its own thickness, from the butt end of the rod. This piece cannot be driven out without shearing off on each side of it the rectangle *p n*, the area of which ought therefore to be equal to that of one side of the strap; that is, to the rectangle 2–4, Fig. 25. But it may be stated that the breadth of the butt end is usually so great that if the distance, *c g*, be made no greater than would be absolutely necessary to give this area, it will not *look* strong enough, although it may really be so, and it is usually made some fifty per cent. greater, as in the figure. In fact, it will be found that in a great many cases the results of calculations are not such as to please the eye; and the results of experience show that no harm is done under such circumstances by the addition of sufficient material to make all parts harmonize in appearance. Another instance is found in the distance, *u v*, from the back of the slot to the beginning of the thick part of the strap, which is usually made such that *v* is not vertically over *p*, but a little to the left of it, so as to avoid a coincidence of lines in the top view. We might make *u v* considerably less than this without weakening the strap, but it would not look well if we did so.

The depth, *q j*, of the head of the gib has usually the proportion shown in the figure, to the thickness of the strap under it. Were the use of this head merely to keep the gib in place, its depth might be made much less. But it serves another purpose; for there is in almost every case some oblique pressure on the rod, which tends to spread the strap open, and one object of the gib is to counteract this. Consequently the projection, *q r*, of the head is really made by the fitter with a very slight taper, so slight that no indication of it is made on the drawing; thus, when the key is driven in, the strap is drawn together and made to hug the sides of the butt end of the rod. The proportion of *r q* to *q j*, given in the figure, is good, and the radius of the circle by which the corner is rounded off should be at most no greater than *r q*, and it will look better if a little less. This is sometimes disregarded, and we have seen the gib-head rounded off by a circle whose center is in the line *r v*, and radius equal to *j q* but the effect is that of apparent weakness, as the reader may easily see for himself by drawing one in that way.

No fixed rule can be given for the length of the key, for sometimes the space at command is limited, so that a long one cannot be used without interfering with some other part of the mechanism. The object of the extra length, as is almost self-evident, is to take up the "lost motion" consequent upon the wear, the butting faces of the brasses being filed off from time to time as it becomes necessary, thus allowing the strap to be drawn farther over the rod. Consequently, the longer the key, within reasonable limits, the better; if there be nothing in the way, it will lock very well if made one and a half times the length of the gib; but its length, as well as its breadth at each end, should be definite, in the sense in which that word is here used—that is, so many inches and quarters, eighths, or sixteenths of an inch. The taper should be one inch in sixteen, if possible; sometimes it is impracticable to make it as long as it should be if the taper is so small, in which case it *may* be made one in twelve; but in that case it is necessary to provide very carefully against the possibility of its backing out, which is likely to happen if the mechanism be such that there is much vibration or jarring when in action; to this we shall allude again presently.

It will be seen that the gib tends to split out a piece from the strap, just as the key does from the butt end of the rod; the area of the rectangle *q s* should therefore be equal to half that of the least section of the strap. Since the corner of the strap at the end is rounded off, the distance *t s* should be a little greater than the quotient obtained by dividing the last named area by *q t*, the thickness.

When the key is driven down, *s* moves to the left; and the point *i*, where the curve of intersection begins, should be so far from *s*, when the whole is new, that when the key has been driven down till *x* reaches *z*, there shall still be some space left between *s* and *i*. Dropping the perpendicular *x y* from *z*, we find *y z*, the "draft" due to the assumed length of the key; *u w* and *f h* should be each a very little more than *y z*, and *s i* should be considerably greater. Consequently, in planning a rod in this way, it is necessary to construct the curve of intersection separately, or at least so much of it as to determine the points *i* and *o*; this should be done on another bit of paper, and the meridian outline, as well as the curve of intersection, afterward copied on the finished drawing.

Thus far nothing has been said about the thickness *b k* of the strap at the crown. So far as the mere pull of the rod is concerned, it would seem that the strength would be ample if the strap were merely bent round the brass, without any increase in thickness. But this would make, with a brass of this form, a very unsightly finish; and, besides, there is the consideration already mentioned, that the oblique pressure on the rod tends to force the strap open. This is prevented at the other end by the gib-heads; but owing to the length of the strap it is found advisable to make it rather heavy in the crown. The outline is a semicircle; and, describing about *e* an arc with a radius equal to the least thickness of the strap, the center of this semicircle is so chosen that the outline shall pass outside the dotted arc just mentioned, and that *b k* shall be a definite dimension.

Allusion was made above to the fact that the tapering key might work loose, and back out by reason of the vibration of the mechanism while running. To prevent this, there is shown in the figure a steel "set-screw," that is, a bolt which is screwed into the side of the rod, and pinches the key when it is driven down to its place. There is also shown a "jam nut," which is a nut that is screwed hard down upon the side of the rod, after the "set-screw" has been tightened. Thus, before the key can back out, this nut must first be loosened, and afterward the set-screw itself, of all which there is little probability. We call attention to the termination of this set-screw, which is hollowed out, forming in the end of the bolt a shallow saucer with a sharp edge. Set-screws are quite frequently made in another and more simple way, terminating merely in a conical point, as shown in Fig. 27. This point will imbed itself in the side of the key, as at *A*; but an objection arises from the form of the cavity thus made, which will be understood by the aid of the second diagram, *B*, in which the screw is shown as backed out, and the key as driven a little way beyond its previous position. Were the change in the position of the key greater, so that the edge of the first cavity should go beyond the point of the set-screw, no difficulty would be experienced; but it will be seen that in the case here shown, the point of the screw will enter the depression, and acting against its right-hand side like a wedge, will tend to push the key back again where it came from. This may easily occur when there is a very little "lost motion" to be taken up; but the difficulty here explained will not arise with the form of set-screw shown in Fig. 24, which cuts a shallow circular groove into the side of the key, so that when the latter is driven down ever so little, the second groove must cross the other in two places, as shown in Fig. 28. It is also to be noted that the set-screw of this form will hold better than the other one, for the very

reason that it bears all round the circumference of this circular groove, instead of in a small spot in the center.

Now, in regard to the execution of the drawing itself. Fig. 24, like Fig. 20, is in itself a complete working drawing. But two views are required, as will be seen by a little study, to explain fully the construction of the whole combination. The separate detail drawings, Figs. 21, 25, and 26, are not necessary for the purposes of construction; we have introduced them merely because perhaps some of our readers may not be familiar with the arrangement under consideration, and these drawings served to aid in explaining it. To be sure, as was hinted in the preceding lesson, those who are new beginners in this kind of work will not be injured by copying these details; but it would be quite absurd to make such drawings for the mechanic. It will also be seen that these are the only two views which *clearly* illustrate the objects shown; an end view or a transverse section, in connection with the side view, would, it is true, enable one to study out the matter, but if the skeptical reader will try the experiment, he will be convinced that the end view is by no means so explanatory, easily read, or in any way so satisfactory as the top view; and the front view is clearly indispensable. The only point which could by any possibility be regarded as ambiguous, in the drawing here given, would be this: that the exact finish of the ends of the key is not absolutely defined. In order to settle that matter, we give in Fig. 29 a detail of the upper end of the key; in which it is seen that, after the top is rounded off, the sides are filed to a slope. The rounded top is a portion of a cylinder, and the sloping sides are plane surfaces. We have then a case of the intersection of a cylinder by a plane inclined to the axis, so that in the top view the curves will be parts of ellipses; but they are such small parts that circular arcs may be used instead, as in the figure.

Now, this is understood to be the way in which the top and bottom of the key are to be finished; and when it is so understood, it will be seen that it is wholly needless to give anything more than the front view, as the angle of the slope is quite immaterial.

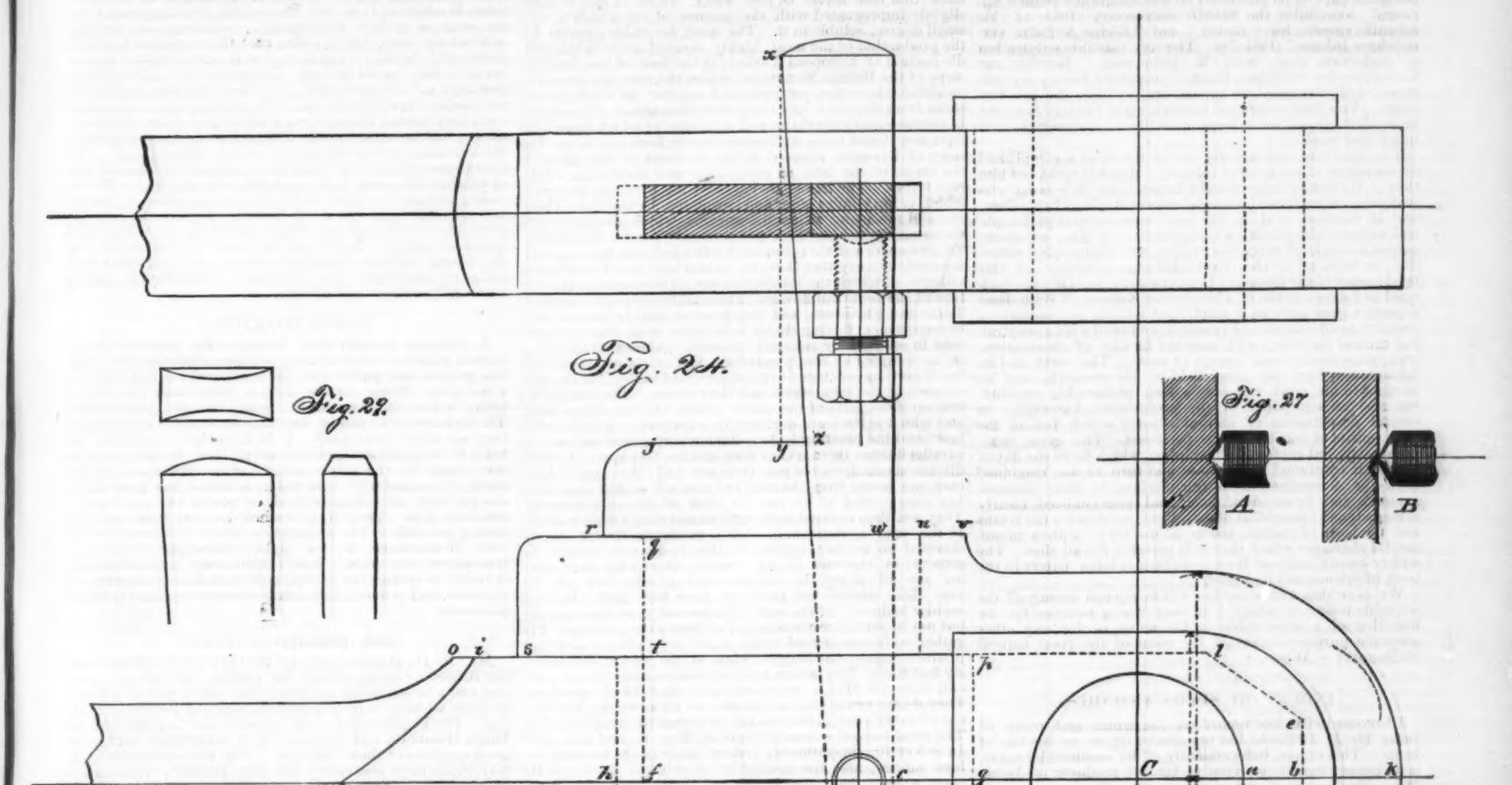
In regard to the arrangement of the views on the paper, it will be noted that the front view of the key runs over the top view of the rod. The object is merely to save space; the top view might have been placed under the other, but there is no objection to so slight an interference of the two views as that caused by the key, whose outlines cross those of the upper view nearly at right angles. We do not, however, intend to imply that this arrangement is always to be adopted in drawing a connecting rod; in the present instance our object was, in the first place, to make our illustration on as large a scale as the space at disposal would admit of; and, in the second, to show that it is not always imperatively necessary to keep the views from overrunning each other. It has already been stated that working drawings should be as small as may be; not only for convenience sake, but because the original being usually retained in the drawing office, and a tracing made for use in the shop, it is advisable to economize material, tracing cloth being rather expensive.

In the drawing of the crown brass, Fig. 26, it will be observed that the center, *o*, of the semicircular part of the outline, is marked by a small circle round it; also, that the diameter of the semicircle is dotted across; its extremities, or, in other words, the points of tangency between the straight and curved parts of the outline are marked with arrow-heads. The same is repeated in the general drawing, Fig. 24; and the diameter of the semicircular outline of the strap is also dotted in and similarly marked. This is not, of course, absolutely essential, but it is well to do this, as it materially aids in reading and in working from the drawing; and, as we have more than once said, anything which does this is a good thing, and it will very often be found that a little time consumed in the drawing office will save a great deal of time in the machine shop. The center lines should, of course, be in red, as also should these dotted lines, little circles, and arrow-heads just spoken of. The center lines, as has been stated, should be full; in this case we find that in the top view, Fig. 24, the center line coincides with the line indicating the abutting edges of the brasses. But the center line being in red, no confusion will be caused by this, as the black one will show, quite obliterating the red one where it is full, and appearing very distinctly where it is dotted.

In the front view the hole merely, tapped for the set-screw, is shown, the outer circle being for the top, the inner for the bottom, of the thread. As the forms of the nut and of the head of the set-screw are distinctly indicated in the top view, no possible good could be done by showing them in the other, as is very frequently done.

We also call attention to one other point. The neck of the rod is shown as broken off; and in doing this it is a very common practice to attempt to show the form of the piece broken off; that being cylindrical in this instance, it would, according to that practice, be shown as in Fig. 30, that is, as though it were broken off obliquely in such a way as to present a foreshortened view of the fracture, which is sectioned. This we regard as decidedly unpleasing to the eye, and abstractly a failure in so far as indicating the exact form is concerned, because it might be elliptical instead of circular in section, and yet present the same appearance; besides, a fracture is not a section, and there is a painful incongruity in such an indication. It is just as easy to suppose the obliquity of the fracture to be such that we can see only the outline, as we have shown it; it is certainly easier to draw it, and, as to the form, that must be shown by other views if there be any question or doubt about it. In the present case, the front view clearly enough indicates that the neck of the rod is cylindrical, by the form of the curve of intersection and the absence of shadow lines; but if it did not, that would hardly be a good reason for attempting to do so in the manner deprecated, since the latter at best does not indicate it with certainty.

[*To be continued.*]



LESSONS IN MECHANICAL DRAWING.—SECOND SERIES, No. 4.

KARL ERNST VON BAER.

SCIENCE has sustained a great loss by the death of Dr. Karl Ernst von Baer, the eminent biologist; he died at Dorpat, on November 29, 1876, in his eighty-fifth year. Von Baer was born in Esthonia, on February 29, 1792, and while yet at the gymnasium became an earnest student of botany. He studied medicine at Dorpat in 1810–14, whence he proceeded to Vienna for the study of clinical medicine; to Würzburg, where he gave special attention to comparative anatomy; and to Berlin, where he studied magnetism, electricity, crystallography, and geology. In 1817 he went to Königsberg as prosector to Prof. Burdach; and two years later he became professor of zoology at the same university. In 1826 he succeeded Burdach in the chair of anatomy, accepted an invitation in 1829 from the St. Petersburg Academy, but returned to Königsberg the following year. A few years later, in 1834, he was again invited to St. Petersburg, where he became one of the most active members not only of the Academy, but also of the Geographical and Economical Societies. Von Baer's writings, marked by philosophic depth, are, on account of their orderly and clear exposition, as attractive as they are generally intelligible. The subject of the origin and development of organic bodies, which had special attractions for him, he did much to clear up. The foundation of his embryology he laid in Konigsberg, where he published, in 1827, his "Briefe über die Enstehung des Eies," which was soon followed by the important works, "Entwickelungsgechichte der Thiere," and "Geschichte der Entwickelung der Fische." These works, which are yet of great value, have earned for their author the title of Father of Comparative Embryology.

In the summer of 1837 von Baer made a journey of exploration from Archangel to Novaya Zemlya, and his report is still one of the most valuable sources of information upon that island. In 1851 his attention was attracted to the immense Russian fisheries, and the irrational methods used. During 1851–56 he investigated the fisheries of Lake Peipus, the Gulf of Finland, and the Caspian Sea, publishing the results of his investigations in a great work in 1859. The name of Baer is connected with more than one improvement in the fisheries, and some important additions were made to the trade: thanks to his efforts. His remarkable work, "Kaspische Studien," has had no rival. It would be impossible to enumerate the various subjects upon which he has thrown clear light in his writings. The laws of excavation of river beds, the navigability of the arctic seas, the steppes and forests of Southern Russia, the glacial period, the Siberian mammoths, the potato disease, were at various times treated by him, and in each department Von Baer opened out new and extensive fields of inquiry. His acquirements in zoology, comparative anatomy, embryology, physiology, and anthropology are well known; moreover, ethnography, the early history of mankind, archæology, and the science of language will count him among their most eminent students. In his later years, besides various anthropological papers, he published an autobiography (which appeared soon after the fiftieth anniversary—1864—of his scientific career), his "Reden," and "Kleine Aufsätze vermischten Inhalts" (1864–75). The very valuable publication he undertook along with M. Helmersen, "Beiträge zur Kenntniss des russichen Reichs," numbers twenty-six volumes, and continued to appear until within the last few years. Von Baer continued to work up to the very last, and he has left behind him a large quantity of manuscripts and unfinished works.

Von Baer was undoubtedly one of the most accomplished investigators of the present century. Haeckel speaks of him thus: "If among living scientific investigators there is one who justly enjoys universal honor and respect, it is Karl Ernst Baer; and if classical, and in the best sense natural philosophical writers, will admire a Coryphæus of to day, an unsurpassed example of exact observation and philosophic reflection, let them go to the 'Entwickelungsgeschichte' of this head master of our science." Helmersen speaks of the late biologist as follows in the *St. Petersburger Zeitung:* "With Baer departs a man such as is rarely met with in any century, a genial man of science and research, endowed with a penetrating critical intellect, with unusual faculty of observation, with perseverance and energy in work. The earth and its inhabitants were the great field of his research, and he brought to his work not only a deep philosophic training, but also an equipment of the profoundest knowledge in several departments of natural science which few of the great spirits of our time have possessed. This great, comprehensive, but profound knowledge, which he to the day of his death continued to increase and turn to use, combined with the determination to trace things to their ultimate grounds, and by means of keen and unprejudiced, clearly arranged, and thoughtful observations, to discover the truths and the laws of nature, stamp all his works with a monumental character which they will preserve for all time. The widely-known name of Baer is written in large letters in the book of science and its history."

We hear that a subscription will be opened among all the scientific bodies of which Von Baer was a member for the founding of a scholarship in his name, or for any other scientific purpose worthy of the name of the great natural philosopher.—*Nature.*

INDIAN OIL SEEDS AND OILS.

UNIFORM with his report on the gums and resins of India, Dr. M. C. Cooke has prepared a report on the oils of India. This report, independently of its commercial value, is an interesting tabular view of the oil products of India. What this report shows more prominently than anything else is the immense amount of undeveloped wealth that lies dormant in the Indian empire. Only the fatty or expressed oils are here treated of, under the heads of waxes, solid and semi-solid fats, and fluid oils. The volatile oils have been reserved for a future report. It only claims to be a digest of scattered and disconnected memoranda, and is not presented as detailing the results of original research. About forty woodcuts, intended to illustrate the seeds, fruits, etc., of oil-yielding plants, are introduced, but the majority of them are so rough as to be of little use.—*Academy.*

MOVEMENTS IN THE LEAVES OF DIONAEA, AND THE PHENOMENA CONNECTED THEREWITH.

Two independent observers have been studying the anatomy and functions of the leaves of *Dionaea muscipula*, one of the insect-trapping plants employed by Mr. Darwin in his experiments to elucidate the question of the absorption of organic matters through the leaves of this and other plants. —M. Casimir de Candolle, in the *Archives des Sciences Physiques et Naturelles*, April, 1876, and Dr. Fraustadt, in the first part of the second volume of Cohn's *Beiträge.* As might be expected, in regard to the anatomy of the leaves, they are in almost perfect accord, but in other respects their conclusions are somewhat different. De Candolle's experiments extended over a period of only six weeks, and, in addition to the question of nutrition, he investigated the mechanism of the leaves. Briefly, his conclusions are these: Animal substances absorbed by the leaves are not directly utilized by the plant, nor necessary to its development. The marginal teeth and edge of the blade of the leaf form a member (organ) distinct from the rest of the leaf, which explains the reason why their movement is not simultaneous with that of the valves of the blade. The stellate hairs and the glands are epidermal structures, whereas the excitable hairs on the surface of the valves are outgrowths of the fundamental tissue beneath the epidermis. The anatomical structure, as well as the development of the different parts of the leaf, favors the hypothesis that the movements of the two valves of the leaf depend upon variations in the turgescence of the parenchyma of the upper surface only of the leaf. According to both observers, no stomates are present on the upper surface af the leaf. Dr. Fraustadt's investigations were of a somewhat different character. Without entering into them in detail we may give the results of his experiments bearing upon the question of nutrition. The cells of the leaves of *Dionaea* exhibit, in many respects, an unusual behavior towards chemical reagents, which seems to point to the presence of a peculiar substance, the nature of which, however, nobody has yet succeeded in making out. Apparently it exists in the living cells in acid solution; consequently it is precipitated by bases and redissolved by acids. Ammonia colors the red glands on the upper surface of the lamina greenish, and precipitates, in the cells containing starch, a fine-grained substance. And if the ammonia is neutralized by acetic acid the red color of the glands is re-established, and the granules in the cells are dissolved and disappear. Adding potassium again removes the color and causes the starch granules to swell up and become transparent. Finally, the green granules are again precipitated. After carefully washing out the potassium, and then treating the tissue with iodine (as iodide of potassium), the cells are uniformly colored blue or violet. Dr. Fraustadt also found that the cells of those leaves which had caught little animals, or had been fed with albumen, contained no starch, or very much less than those which had access to no organic food, after these substances had been enclosed a few days. When dyed albumen was presented to the plant, the color was absorbed even into the vascular bundle of the midrib.

OTTO OF ROSES

THE most delicious of all perfumed essences is obtained by the simple distillation of rose leaves. In our climate, roses are not sufficiently highly scented to produce the properly odoriferous essence or oil; and all that the druggists can produce from rose leaves is rose water, which in fact is water slightly impregnated with the essence of oil, which is, to a small degree, soluble in it. The most favorable country for the production of the most highly scented roses is the middle portion of European Turkey, at the base of the southern slope of the Balkan Mountains, where the roses are grown in localities where they are protected against all winds except those from the south; and the flowers thus attain a luxuriance in perfume and growth, as well as in size, of which those who have not visited these regions can hardly form any idea. The town of Kézanlik, situated in the province of that name, is the center of the field of cultivation and distillation of the rose leaves. The leaves are gathered all over the province, which is forty miles long, and is watered by the river Thungha and the many mountain streams which discharge into the same, furnishing the water necessary for the distillation. To give an idea of the extent which this industry has attained, we need only say that there are in that province 128 different villages, of which the inhabitants are all employed in the culture of the beautiful flowers. These all live in peace together, Turks and Christians; and they prosper, having become wise by experience, finding that it is better to work than to waste time in religious or political quarrels. Almost all the country is occupied by rose plantations, and only a comparatively small portion is devoted to raising rye and barley, for the subsistence of the inhabitants and their cattle. The rose grows best on those parts of the slopes where the sun shines most, and which is the least northern in exposure. A light soil is best; and the planting is done during spring and autumn, in parallel ditches three inches deep and five feet apart. In these ditches shoots from old rose trees are laid; they must, however, not be cut from the tree, but torn off, so that each shoot has some portion of the root or bark of the root adherent. They are then covered with earth mixed with a little manure. If the land is horizontal, and a mountain stream can be diverted so as to inundate it, this is done to hasten the growth; at the end of six months, shoots are seen coming up all along the furrows, and at the end of one year these shoots are three or four feet high, forming regular hedges. At the end of the second year, roses appear, but not in sufficient abundance for them to be gathered. The gathering is commenced in the third year, after which they produce largely, the hedges being, at the end of five years, six feet high. The bushes produce flowers until fifteen years old, when the field is worn out, and must be ploughed up. They do not prune the rose bushes at all as we do, but they cut off every year, in the late fall or winter, the dead branches. The great harvest commences about May 15, and lasts until June 5 or 10; the gathering is done daily in the morning before sunrise, and the distillation is finished before twelve noon, so as to have the benefit of all the freshness of the flowers, which is at once driven off by the heat of the day. In hot seasons, the roses open more rapidly, and the crop may last but for ten days; but in wet, cooler seasons, the progress is slower, and the crop may last for twenty-five days; but then the daily harvest is smaller in proportion, so that the final result is about the same. However, cool, slow weather is preferred, as it eases the daily labor. The stills used are of the roughest kind, and small; they hold from 200 to 240 pints of water, and are carried to the rose bushes to be filled. To 20 lbs. rose leaves, 160 pints of water are added; and the whole is distilled at a gentle heat until 20 pints of water are distilled off. This quantity contains nearly all the perfume of the leaves, which are then thrown away with the remaining water; and the still is again filled with 20 lbs. leaves and 160 pints water. This operation is repeated until all the leaves have been used. The water thus distilled off is a strong rose water; and the result of eight or ten distillations is put in a still and submitted to a second distillation, when a stronger rose water is obtained; so strong indeed, that it is unable to contain the essence in solution, and the latter floats on the top of the water. Experience has shown that, for every ounce of otto of roses, 3,000 lbs. of rose leaves are required. The total yearly production of eight districts, into which the 160 villages of the province of Kézanlik are divided, is on an average 3,500 lbs. of otto of roses, of which the district in which the capital is situated produces half. Some years ago, however, the bushes were exceptionally prolific. Thus, in 1866, 6,000 lbs. were produced; but in 1872 only 1,700 lbs. could be obtained. We ought to add that every rose farmer has his own stills for producing otto of roses immediately after picking the flowers; and thousands of industrious workers are thus occupied, earning in a single short period of twenty days the products of a year's labor in preparing the soil, planting, and taking care of the growing plants. When the distillation is over, the farmers come from all parts of the provinces to the capital to sell their products, those who have large quantities selling directly in the great commercial centres, such as Constantinople and Adrianople. At present, however, an enterprising firm in Kézanlik, considering the delay to which the trade with the last named cities is subject, and the chances of adulteration, have established a depôt in Paris, France, from which this delicate and expensive perfume is now distributed over Europe and all the world.

APRICOT PULP,

Under the name of "kaissapyta," is prepared only in the island of Cyprus, and exported to Alexandria, occasionally also to Constantinople. It is made from the pulp of the *Prunus armeniaca* (the apricot), called by the Turks "kaissaa;" the pulp being spread upon marble is dried, then rolled up like cloth, and preserved to be eaten during the winter in place of fruit; pieces being cut off with shears.

THE CUCUMBER IN RUSSIA.

WHAT the onion is to the Spaniard, or the potato to the Irishman, that the cucumber is to the native Russian. It is the indispensable part of every Russian peasant's meal. In the account of his trip up the Volga to the great fair of Nijni Novgorod—which, by the way, packs the greatest amount of instructive and entertaining description in the smallest space of any book of travels—Mr. Munro Butler Johnstone remarks upon the profusion of water melons and cucumbers everywhere offered for sale. At the fair, and on the road thither, pyramids of melons, like cannon balls in an arsenal, were heaped up in every direction; and, as for cucumbers, one couldn't help thinking that a plague of cucumbers, like locusts, had descended upon the earth. All along the Volga, from Astrakhan to Nijni, the whole population seemed engaged in eating water melons, which were sold for three copecks, equivalent to one English penny. At every station the trade in melons was rivalled only by the traffic in sunflowers. But if the water melon and the sunflower are luxuries and pastimes, the cucumber is a law and a necessity. One never sees a Russian peasant at dinner without a lump of black bread and a cucumber. "A moujick's dinner may be said to consist of $x +$ cucumber." The x will consist of his favorite cabbage soup, with or without meat in it, and sometimes in addition to it, the famous grit porridge; sometimes the soup is without the porridge, sometimes the porridge without the soup, but in either case the cucumber is always there; and should x equal zero, then the ever faithful cucumber does duty for all the rest. In the hot and arid regions of Southern and Southwestern Asia, these succulent vegetables are highly appreciated, and with good reason. Juicy and cool, they cannot but be always refreshing where water is a rarity; but in a climate like that of Russia, the cucumber is the last thing one would expect for a national dish. Mr. Johnstone suggests that their price—about the fifteenth part of a halfpenny—may help to explain the anomaly. We are rather inclined to think it likely that the Russian peasant eats cucumbers, not so much because they are cheap, as because his remote ancestors, who came from the South, were cucumber eaters. To the one the taste for cucumbers was the natural result of climatic conditions; with the other it remains an inheritance and a national eccentricity, in spite of a naturally unfavorable climate.

DRIED POTATOES.

A GERMAN journal thus describes the manufacture of "dried potatoes" as conducted at Carsten's works in Lubeck. The potatoes are peeled with the hand, and cut into disks by a machine. These are put into a basket, and this into a boiler, where the potatoes are nearly but not quite boiled. The disks are next put on wire frames in a dry oven, where they are dried quite hard. It is important to preserve the color of the potatoes, and to prevent their turning gray, as they would by the above process alone; the material after slicing is treated with cold water, to which has been added one per cent. of sulphuric acid, or one to two per cent. of muriatic acid. Then it is washed in pure water, and the drying proceeds. The preparation obtained, which has lost none of its starch, is of a slightly citron-yellow tint, and transparent like gum. Boiled with water and a little salt, it is said to resume the natural color and fibrous structure of potatoes, and is not distinguishable in taste from newly boiled potatoes.

THE BRIGHTON GRAPE

MR. R. H. HAINES states in the *Country Gentleman* that the Brighton coming among the earliest, and being of good size and a beautiful red in color, will prove very acceptable to those wishing to have a good display and variety for table use. The Brighton is a cross between the Concord and the Diana Hamburg, and combines in a remarkable degree the good qualities of these varieties. The vines grow very rapidly, ripen their wood early and very perfectly, rendering it of special value for general cultivation.

As to quality, it seems to have retained to an unusual degree the delicate flavor of the Hamburg, comparing favorably with some of our most desirable hot-house grapes. The berries are sweet, with little pulp, and may be classed among our larger varieties in point of size. The bushes are of good size; some would call them large. They are seldom if ever disfigured by having the fruit drop from the stem. The vines may safely be called productive—perhaps "very productive" would be a more accurate designation.

IMPROVED AERATED BREAD.

THE improvements consist in what is technically called the "wine process," and consists in forming a wine from malt by mashing, and afterwards setting up the vinous fermentation in closed vessels. Four gallons of the so-called wine are mixed with the necessary water for a sack of flour, drawn into a closed vessel, and aërated, that is, charged with carbonic acid gas, like soda water. This soda water is then mixed with the flour (in strong, closed vessels), and kneaded by arms driven by machinery. The dough formed is drawn off by machinery (thus dispensing with any intervention of the human hand) into the required loaf sizes, and at the same moment as the carbonic acid gas passes out of it, the dough is raised and vesiculated, and ready for the oven, the whole time required for forming a sack of flour into loaves not being more than half an hour. The effect of the new wine process on the flour is, we understand, that the gluten cells of the starch are softened and broken up, and the dough is thus entirely altered in its character. Instead of being tough and harsh as formerly, the dough now becomes soft and elastic; it is easily kneaded, requiring only half the power to work the kneading arms, and the atmospheric pressure required in the vessels is only about 20 lbs. to the inch, instead of 90 lbs., as hitherto. The use of such low pressures, besides being a great pecuniary gain, is of considerable importance in giving to the bread a soft and beautiful pile-like texture. The dough, when prepared by the new wine process, also soaks and bakes with the greatest ease, and at an oven heat of 100° less than the oven heat hitherto required for aërated bread. The starch of the flour is now changed into dextrine, while the gluten is uninjured, and the bread has a sweet and agreeable flavor, free from that acidity and bitterness always more or less present in fermented bread. This improved system of making aërated bread is especially important in the manufacture of whole meal bread—a large quantity of which is now, we are informed, made and sold by the London Aërated Bread Company. It is a fact well understood and insisted upon by the medical profession, that whole meal bread is a necessary part of the food of every people, and that the *physique* of the nation would be raised and improved by its daily and general use. I therefore look upon the new process of making aërated brown or whole meal bread as an invention of great national importance.—K. L., in *The Miller.*

PHOSPHIDE OF ZINC.

PHOSPHIDE of zinc is one of the very few articles that have stood the test of experience out of the very many additions to the Materia Medica introduced in recent times. In fact, the large range of nervous affections that resist almost all forms of medication, renders it very important to the practitioner that those remedial agents which have stood the test of experience in treating these often too stubborn affections, be brought prominently before his attention.

The phosphate of zinc, so far, has proven a most efficient agent in the successful treatment of the major part of a certain class of affections. In very many instances it has been far more curative in these cases than phosphorus. Considered in the light of a curative agent, the phosphide of zinc stands alone, not only for the certainty but for the rapidity of its action, as a nervous tonic and stimulant. Its value in these respects has of late been fairly tested in the last and exhausting stages of typhoid and other fevers where the nervous energies have been so far prostrated as to render convalescence, if not doubtful, at least tedious and protracted.

The great therapeutic value of the phosphide of zinc is declared in the most emphatic manner when used in the treatment of that protean form of disease known as *neuralgia*. Compared with phosphorus as a curative agent in neuralgia, the phosphide of zinc has decidedly the advantage in numerous respects. While it is acknowledged by the best observers in the profession, that the former is seldom curative in doses less than one-twentieth of a grain, often calling for as high as one-tenth and one-fourth, the phosphide of zinc yields as reliable and more speedy results in doses of one-tenth to one-eighth of a grain. But few stomachs can tolerate more than one-thirtieth of a grain of phosphorus before manifesting symptoms of irritation, which, in connection with the "matchy" taste soon evolved in eructations following an efficient dose of phosphorus, seldom fails to engender disgust to its farther continuance. Nor are these disagreeable results altogether abolished by any of the multitudinous formulæ now in vogue. These drawbacks and inconveniences are no doubt caused by the length of time phosphorus remains in the stomach before it is absorbed. On the other hand, experience with the phosphide of zinc has proven that it enters the circulation far more rapidly than the element, and when administered in doses of from one-eighth to one-twelfth of a grain, produces its curative influence far more readily, and is equally as permanent in therapeutic power.

In neuralgias, especially those that are due to loss of nerve force or exhaustion of the general system from causes that have lowered the constitutional resistance of the vital economy, it acts sometimes so like a charm as to challenge the gratitude of the patient and the admiration of the prescriber.

Not many months ago I was treating a case of neuralgia of the fifth pair, which showed so rebellious a front as to resist such remedies as ergot, belladonna, the bromides, quinine and hyoscyamus, combined with morphia, iron, etc. I resorted to the phosphorus pill, but soon found that the patient could not take enough of the remedy to do any good, before disagreeable symptoms in the stomach presented themselves, which, with the disgusting matchy eructation, engendered such disgust as to cause me to withhold its further use. At this juncture I ordered phosphide of zinc, one-eighth grain every four hours in pill form. After the fourth dose, the pain was materially modified, and in three days there was entire cessation of pain, from which date recovery was permanent.

In a case of undoubted angina, I found the phosphide of zinc a most remarkable remedy for good.

I am unable to say what the value of the remedy would be in mania. However, it seems from what I have heard and read of the results obtained from its use in this class of diseases, that it promises to be valuable.

Loss of memory and impotency are very favorably influenced by the phosphide of zinc. A gentleman engaged in large mercantile transactions, whose mind was kept intensely occupied with his business for many hours during the day, complained to me that he found his memory (that had always, up to a few months before, been remarkably retentive) becoming treacherous—that he was getting very forgetful. I gave him two dozen phosphide of zinc pills, requiring him to take one three times a day. I saw him a week after, when he said he saw no difference in his condition. The pills were continued three weeks longer by taking four a day, at the end of which time he was feeling much improved. With this he was encouraged to continue the treatment three months steadily, until he regarded himself cured.

Another instance of a loss of sleep from continued mental anxiety, in which the patient complained of being unable to sleep longer than one or two hours during the night. Phosphorus in this case was ill borne. Phosphide of zinc in one-twelfth grain doses every four hours was prescribed. The remedy exercised a good control over the case in a few days, which, after six weeks' constant use, restored the lost balance of the nervous system.

The power of the phosphide of zinc in controlling nervous affections that have their origin in exhaustion or depression of the nervous forces, is now beyond a reasonable doubt. When properly administered and persistently persevered in, its curative value in these classes of cases is sufficient to merit the attention and confidence of the profession at large. Having none of the disagreeable effects of phosphorus, its rapid absorption into the circulation, its mild stimulant and tonic influences on the nervous centers, recommend it as a valuable curative agent in all forms of disease requiring phosphorus for their cure

The formula recommended by Prof. William A. Hammond: ℞ Zinci phosphidi, grs. 1-10; ext. nuccis vomicæ, grs. ¼—in pill, I have obtained remarkably good results from.—*St. Louis Med. and Surg. Journ.*

BOILS AND CARBUNCLES—THEIR TREATMENT.

DR. P. EARL (*British Medical Journal*), directs attention to this subject:

1. Boils and carbuncles are not mere inflammation and sloughings of cellular tissue, but specific diseases.
2. They are parasitic, and as such endowed with a definite life and history.
3. In their early stages they may be infallibly destroyed and aborted by destruction of their central stem or root, and even after this stage is passed they may generally be destroyed, and in all cases, at the very least, greatly modified by the free application of carbolic acid.
4. To produce this result the acid must be freely introduced into the central portion of the disease, and also into any other part where an opening exists or is formed artificially. The strength of carbolic acid used was four or five parts to one of glycerine.

SYNTHESIS OF HYDROGEN PHENYL SULPHATE AND ITS HOMOLOGUES.

THIS compound, which the author, E. Baumann, discovered in urine, is easily obtained by the action of pyrosulphate of potassium, $K_2S_2O_7$, on a concentrated aqueous solution of potassium phenylate. Corresponding compounds of cresol and resorcin are obtained in a similar way.

AMMONIACAL SALTS.

M. LEON KRAFFT treats of the preparation of ammoniacal salts from the drainings of cesspools. These liquids are either mixed with sulphuric acid or filtered over sulphate of lime, the result being in either case the conversion of the volatile carbonate of ammonia into the fixed sulphate. The liquid, rendered limpid and clear either by settling or filtration, is evaporated down to one tenth of its volume either over the naked fire, or by the "graduation" principle. It is then absorbed by a powder composed of turf, bone black, mineral phosphate of lime, and baked gypsum.

PREPARATION OF THALLIUM.

DR. R. NIETSKI.

THE author is not satisfied with the method of Krause. He takes the chloride of thallium, moistens it with water slightly acidulated, and adds a few fragments of zinc. After a few days all the thallium is separated in a spongy mass, which is carefully washed, and dissolved in hot dilute sulphuric acid. The foreign metals and the other impurities remain undissolved. A pure and concentrated solution of sulphate of thallium is thus obtained, from which the salt may be separated by crystallization, and the metal may be obtained either by a galvanic current or by means of zinc.

IMPROVED OPHTHALMOSCOPIC MIRROR.

DR. EDWARD G. LORING states in the *Medical Record* that Dr. O. F. Wadsworth, of Boston, has recently made an ingenious and what promises to be a useful addition to his ophthalmoscope. This consists of an additional mirror, designed particularly for the use of the upright image and the determination of the errors of refraction. The mirror is circular in shape, and of the same focus as that now ordinarily used. The peculiarity of the mirror is that it is only fifteen millimetres in diameter. The small diameter of the mirror permits it to be set at an angle of twenty degrees, and yet allows the hole in the mirror to be brought close to the glass in the disk. The mirror rotates from right to left, so that either eye can be examined. The disadvantages of this mirror are, that it is so small that sufficient light is not obtained to make an examination by the inverted method, thus necessitating an alternate substitution of two mirrors. To avoid this necessity, he has contrived the following modifications of the ordinary mirror, suggested by Dr. Wadsworth's idea:

The general shape of the mirror is kept as it now is, except that a segment is cut from one side, a straight line having been drawn in a vertical direction about half way between the center of the hole and the edge of the mirror. The mirror is then swung on two pins in a vertical direction. When an inclination is needed, the mirror is tilted down into the case, at the side which has been cut away; and, as only ten degrees of pitch within the case is needed, the present case is deep enough. When needed for the inverted image, the mirror can be folded back, or indeed used just as it is. This mirror rotates from right to left. It gives abundant light for either method of examination, and can, if thought advisable, be protected by a case similar to that of Jaeger's mirror.

This modification has been rendered still more simple by cutting off both sides of the present mirror, making in fact a narrow parallelogram sixteen millimetres in width, instead of a circular mirror. This tilts both ways in the case, and does not have to be rotated, and can be used perfectly well for either upright or inverted image. If more light should be needed, it can be obtained by having the segments, which have been removed, restored. The mirror would then consist of three parts—a central portion which swings on pivots, and two side portions which remain stationary. Still a further modification towards the same end, and one which is more elegant but more expensive, is to have a small central mirror swung on pivots, surrounded by a concentric stationary mirror. These mirrors can be fitted to any ophthalmoscope. By such an arrangement we do away, in a great degree, with the astigmatism which is produced when strong glasses are used, and when the mirror lies in a plane parallel to that of the correcting glass, as is the case with the ophthalmoscopes now in common use.

THE PREPARATION OF SULPHIDE OF IRON.

IT is best accomplished, according to Dr. Méhu, by mixing two parts of finely powdered pyrites or bisulphide of iron with one part of powdered iron, and heating the intimate mixture in a Hessian crucible to redness for half an hour. It is unnecessary to increase the heat to fusion; a gray mass is obtained which is easily pulverized, and in contact with hydrochloric acid, copiously evolves sulphuretted hydrogen.—*Zeitschr. d. œst. Apoth. Ver.*

PETROLEUM BENZIN IN PHARMACY.

By L. WOLFF.

PETROLEUM benzin has been frequently proposed and variously experimented with by different operators, with the view of substituting the much higher priced ether in preparing oleoresins, and has been repeatedly found to not answer the purpose intended for it. Although its valuable solvent powers for fatty matter, wax and essentia oils cannot be disputed, it fails to extract the resins and the active ingredients, which are of the utmost importance in oleoresins. Ginger treated with benzin yields an oil containing all the odoriferous properties thereof, but extracting none of the pungent tasting resin for the remedial properties of which it is justly celebrated, and which subsequent to the benzin process is readily dissolved from it by ether or alcohol. Buchu under a like treatment, as reported by another contributor of this journal on this subject, gives an oily substance devoid of the diuretic properties of the leaves, though possessing their specific odor. Cubebs, though completely exhausted by it of its fixed and essential oils, fails to yield its cubebic acid to it, black pepper its piperin, and wormseed its resin and santonin; but all of the mentioned substances, and many more which have been subjected to the same process, are readily deprived of their fixed and essential oils, leaving them inodorous, seemingly dry and incoherent, powders, that are, if treated with alcohol, ether or chloroform, readily deprived of their resins, thus affording a method for obtaining them separate from wax, fixed and essential oils.

Its extraordinary solvency for essential oils destines benzin for an important place in pharmacy, and oils derived by its aid from cinnamon, cloves and other drugs are, if their odor is any indication of their value, if not superior, certainly not inferior to the distilled oils of these articles.

The oils obtained by exhaustion with benzin and its subsequent evaporation are mixed with wax and fixed oils to some extent, which can easily be separated therefrom by dissolving in alcohol, in which the latter are insoluble, filtration of this solution, and either expulsion of the alcohol by evaporation at the moderate heat of a water bath or, much safer and better, by mixing the filtered alcoholic solution with several times its bulk of water, when the essential oil will arise to the surface or subside beneath it, as its specific gravity may be.

The oils by this cold process have a beautiful aroma, superior to many of the distilled ones, and the easy manner of obtaining them may, without doubt, prove a valuable method for the pharmacist who cannot always procure in the market the oils he wants, and has no facilities for distilling them, besides giving him fair means to arrive at a quantitative estimate of the essential oil contained in an article under analysis.

PREPARATION OF APIOL.

The essential oil of parsley seed cannot thus be separately prepared by the aid of benzin, as it contains another peculiar oily substance, well known by the name of "apiol," which is soluble both in it and also alcohol.

A great deal of the apiol in the market, both in bulk and in capsules, is nothing more than an oleoresin of parsley seed, which can lay no claim whatever to its name, being of green color, insoluble, to a large extent, in alcohol, and congealing at ordinary winter temperature, all of which properties "true apiol" does not possess. Apiol has come into extensive use of late years, secured high praise as an emmenagogue, and is also claimed by its discoverers to be an antiperiodic but little, if any, inferior to quinia: but its high price, consequent to the expensive process as proposed by Messrs. Joret & Homolle, perhaps more than anything else, prevents its general introduction.

Powdered parsley seed, exhausted with benzin, and the liquid spontaneously evaporated, yields a mixture containing principally fixed oil, wax and apiol; the latter, alone, being soluble in alcohol, can readily be recovered therefrom by repeated washings in stronger alcohol. The washings evaporated over the water bath with a gentle heat leave as residue "True Apiol," corresponding in every respect with the article sold under the name of "Joret & Homolle's," having the advantage of its low price, making i accessible to persons of limited means, as well as to the more favored by fortune, especially if it is not dispensed in capsules, for which there is no occasion, since it may be given dissolved in essence of peppermint, or in emulsion, disguised by the oil of the same name. Samples of "apiol" prepared in this manner have been tried by several prominent physicians, in their practice, and were pronounced to be equally as efficient as the imported French article.

Quite frequently the fixed oils much encumber the result of pharmaceutical operations, as is prominently the case in preparing the "Alcoholic Extract of Nux Vomica," which has often been noticed and given attention to by many writers Nux vomica, if exhausted with benzin, yields a large percentage of a clear fixed oil, congealing at ordinary winter temperature, and the powder, if subsequently treated in the usual manner with stronger alcohol, gives an extract which offers no trouble by proper evaporation in reducing it to the dry state. The oil derived from the benzin exhaust, to make sure of not losing any strychnia or brucia that may be contained therein, should be repeatedly shaken with dilute alcohol until the washings fail to betray to the palate the specific bitter taste of their alkaloids; then the washings must be mixed with the extract in course of evaporation, and the whole reduced to proper consistency. By the ordinary way, the separation of the oil from the extract is at best a tedious matter, causing the loss of extract, and is never completely performed, thus preventing evaporation to dryness, which by the benzin process is readily effected.

"Purified Oleic Acid" can be easily, and at small expense, prepared with benzin as solvent, in the following way:

PREPARATION OF OLEIC ACID.

Oil of sweet almonds, saponified with caustic potash and the soap decomposed with tartaric acid, is washed with hot water to separate the precipitated bitartrate of potassium from the mixture of oleic and palmitic acids. These are combined with litharge forming the oleomargarate of lead, from which the benzin dissolves the oleate of lead, leaving as residue the undissolved palmitate thereof. From the benzin solution the lead is precipitated by dilute hydrochloric acid, in form of chloride of lead, and on evaporation of the benzin, "Oleic Acid" will remain sufficiently pure for pharmaceutical purposes, giving clear and permanent solutions with the red and yellow mercurial oxides, as high as thirty per cent. if necessary.

As crude commercial oleic acid can be bought at very low figures, it may be purified by combining it with litharge, deriving from it the oleate of lead, from which again, by the aid of benzin, the purified oleate can be separated, and, as before stated, purified oleic acid prepared at but a small expense.

To gain the same end, the simplest way perhaps is to utilize the ready made oleo-palmitate of lead, the officinal lead-plaster, dissolve it in benzin and extract from it the oleic acid by precipitating the lead by aid of hydrochloric acid.

Oleic acid thus prepared has been used for some time, and found to answer better for the preparation of the oleates than the article sold by some of the manufacturing chemists.

The above results by no means limit the utility of petroleum benzin as a solvent and important pharmaceutical factor, but they will show that this refuse article, of comparative little commercial value, which has been applied to but little more than the removal of oil, grease or paint stains, may be turned to good account by its very deficiency to act like ether or similar substances as a general solvent for both fats and resins.—*American Journal of Pharmacy.*

SCARLET FEVER.—Dr. Pigeon, of Clifton, claims marvellous success in the treatment of scarlet fever by the following method: "Anoint the patient twice daily with sulphur ointment; give five to ten grains of sulphur in a little jam, three times a day. Besides this, the room is filled twice daily with sulphur fumes. Under this treatment," he says, "each case improved immediately, and none were over eight days in making a complete recovery; and I firmly believe that in each case it was prevented from spreading by the treatment adopted."—*Lancet.*

THE TABLE AS AN OBJECT OF ART.

By Dr. Stockbauer.

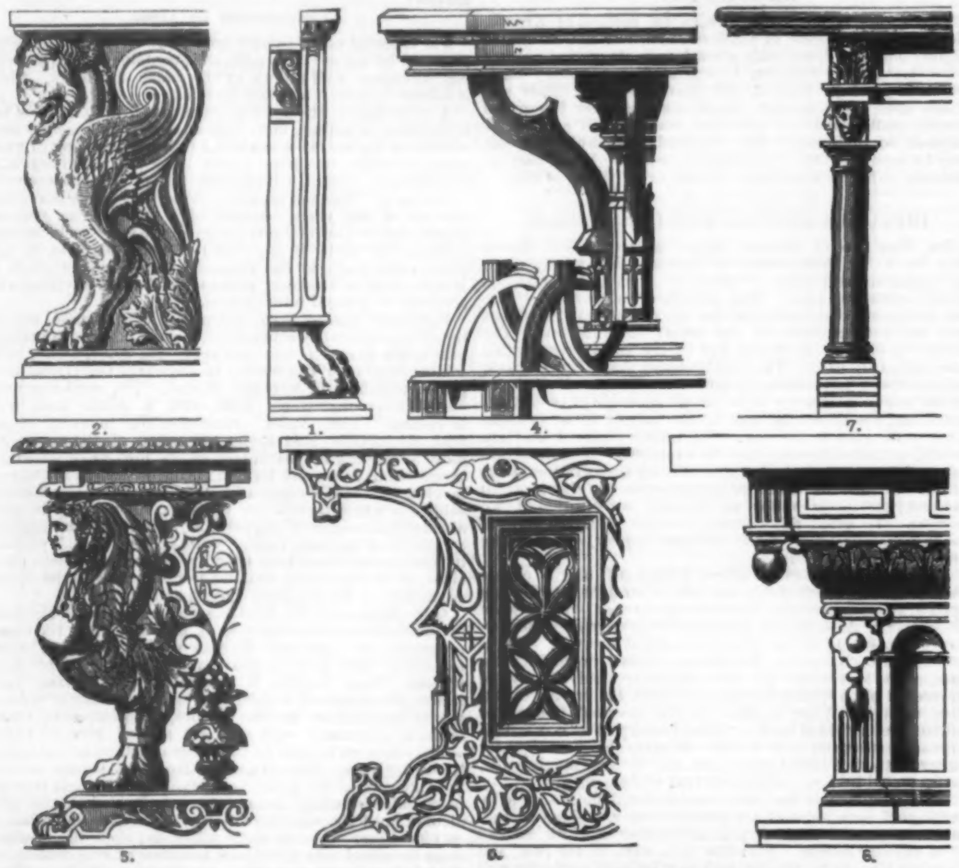
In the department of furniture there is no one article which stands in such intimate relation to civilized life as the table. Sofas, chairs and cupboards, beds and chests have a more exclusive and self-dependent importance; the table, on the contrary, is in its general form the central point of the family and social life. The table more than any other article of furniture shows the varying spirit of the times and the characteristics of the tendencies of art which prevailed in those several times.

If, in tracing the development of this piece of furniture, we separate the supports from the slab, we must necessarily begin with the tables of the Romans. Writings and paintings speak of and exhibit a multitude of tables which were in use among the Romans; there were the little round tables with one leg, the foot of which was of ivory; the little three legged tables of bronze; the four legged tables with straight pillar-like legs often fluted (No. 1), with claws for the feet; small ornamental dining tables placed one by one before each guest; sideboards for the display of costly vessels and plate, hence called mensæ vasariæ; money changers' tables, and those destined for divine service; all these, however, must yield to the marble tables found in Pompeii, which, in point of artistic execution, are of universal and preminent importance. As the Italian Greeks are always distinguished by their acquaintance with nature, the feet (No. 2), are shaped like lions' legs and claws, supporting in a lying posture the slab above; the head, which is placed over the thigh, finishes the support, but does not directly come in contact with the slab, because, as in nature, so in art, the head is not used as a supporting but a crowning and supported member. This table is indeed an unsurpassable example of the style in which natural animal motives may be artistically treated. The disproportionate predominance of decorative features over the constructional forms which characterized the later Gothic period is particularly found in the supports of the one footed tables, which were not only surcharged with an exuberance of such details, but disfigured by them in an illegitimate and irrational manner (4).

In the configuration of the Renaissance furniture, the best known artists were Ducerceau, and his contemporary Bredeman. To them we are indebted for a number of most beautiful and graceful examples which served for models for the furniture makers of their time. In their designs we perceive three kinds of treatment, two of which are derived from the antique and the preceding Gothic period, but the third is an entirely original and independent creation. To the antique belong the use of the Sphinx and other figures which were appropriated to the more richly appointed tables, and may be called free imitations of similar Romish marble shapes with the natural modifications which distinguish wood from stone (5). Of the same kind as the above named Gothic supports are designs, like No. 6, in which the decoration is necessarily conceived and disposed in a new spirit. The central part, which, at an earlier period was more or less pierced, is here supplied with niches and flanked right and left by pilasters. This architectonic motive then finds its most beautiful and natural expression in the baluster and pillar-like foot, shown in 7 and 8.

In the period called Louis XIV., the inflated magnificence was no longer content with the simple and natural shapes of the past, but trimmed them up with glaring additions to produce effect, so that the legs of tables were rarely to be seen without some extraneous heavy ornaments of gilt bronze, which at first were, correctly enough, applied only to the connecting and finishing pieces, but at a later period were met with in every part (9). By means of such decorations, and strengthening by metal settings, the circumference of the wooden supports could be diminished, and thus, instead of the bulky legs of the sideboards, appeared a host of slender ones, with a slight resemblance to antique models, which (as in No. 10) perform their supporting function in graceful lines. But in the time immediately subsequent, during the reign of Louis XV., these forms were distorted into most irrational shapes. The feet of the tables with all their Rococo decorations despise every trace of organic articulation and development, being composed, like stucco ornaments and porcelain, of twisted and spiral pieces entirely destitute of any logical foundation and absolutely contradictory to the qualities of wood and supporters (11). Still this indissoluble discord between the material, the purpose and the form, was somewhat mitigated by gilding the whole and giving to the wood the appearance of metal.

The sober time of Louis XVI. put an end indeed to these extravagancies, but went itself into another and still worse extreme. The antique discoveries of that period, as they were in agreement with the efforts after natural simplicity, were worked up in preference to all else for the wants of the moment; but the time had become so unartistic, so sickly and so unproductive of anything original, that even the antique forms which might have been directly employed, were crippled and spoilt, not to mention the new specimens which were derived from such examples. All that was thought of was outward form; as to a deeper search into the legitimate effect and connection between material and technic, or any study of the significance of color, etc., this was so much the less attended to, as for fifty years past such questions had no longer been canvassed. And color was just the sore point in those sickly times. Everything was colorless; all was white and gray, and the stucco mania of the foregoing period had covered everything, which used to be executed in a different material and decorated with color, with stucco imitation of marble. So even the feet of the tables had a coating of marble, and as they were most frequently executed after Roman or pseudo-Roman bronze models, their meagreness and meanness contrasted all the more with this imitation of marble (12). If in earlier times wood was treated like bronze and metal, it was at least covered and gilded; now it was equally treated like metal, but given the appearance of marble, so that material, color and form might be said to lie to one another.—*The Workshop.*



THE TABLE AS AN OBJECT OF ART

NEW DISCOVERIES AT POMPEII.

Those who have excavated to deeper levels in other parts of the classic earth have carried on their work, up to the actual moment, with great success, if little ostentation, and day by day it has shown that we have still to learn more of the buried city of Pompeii than has been learned hitherto. It is found that the ashes of the mighty eruption extended farther, and that their heaps rose higher, than when the diggers of a generation or more ago came upon those narrow streets, with lofty pavements, and low sunk gutters, and stepping stones to assist the foot passenger in crossing them when heavy rains descended; that architecture described by Vitruvius, those beautiful houses, composed of atrium, peristyle, painted banqueting rooms and bed chambers, fountain courts, polished pavements, inscribed walls, and painted surfaces, telling us nearly all we know of ancient graphic art.

It would be superfluous to analyze the index to these recent disinterments of ancient art; but some points in connection with them are of more than antiquarian interest. Thus, the whole of the mythological legends belong, without an exception, to Greece. The colors of the female clothing are usually of bronze green or saffron, red or rose, the last sometimes tinged with yellow, with, in rare instances, a mass of purple, scarcely dimmed by the lapse of centuries. Again, we perceive an almost invariable repetition of those ivory tinted skins, brown and curly locks, and mimicries of sculpture which are reputed to have been at a certain period fashionable with the Athenians. M. Houssaye, in his latest exposition upon this topic, is glad to have found that the most recent discoveries have amply confirmed his impressions of two years ago. He notes, however, a remarkable coincidence. There has been a picture exhumed at Pompeii, representing the Three Graces, which Raphael, of course, could not possibly have seen, though he might, in the course of his studies, have fallen upon some imperfect reproduction of it. Yet the two compositions, while of different dimensions, are precisely the same—in grouping, in form, in expression, and even in charm. Now, not even a sketch of the pure antique was known until long after the middle of the eighteenth century, while the actual picture is a modern revelation altogether. We owe it, indeed, to the critical acumen of those who have been enabled to distinguish between the authentic work of the Greeks and the libertine imitations of the Siennese, though how those latter obtained their designs and models it is difficult to say. These identities may be still further pursued, but the marvellous fact suffices that Raphael, copying a statue, applied the very same process to his painting which had been employed by his predecessors fifteen centuries previously.

Within the last few years forty figures have been redeemed from out these artistic tombs, which were evidently details of an immense composition, intended for the adornment of a theatre or a banqueting hall; but it must be remembered that there were two Pompeiis; the first buried beneath the second, before the second was overwhelmed by the ashes and lava. In the former have been found, far more universally than when M. Houssaye carried on his investigations in 1874, pictures of lightly clad figures floating through the air, relieved against brown, black, or crimson skies, with masses of carnation cloud beneath their feet, and genii hanging, so to speak, around them, enveloped in robes of hyacinth, blue, green, and so on, the colors appearing to be laid thickly, upon partially vitrified surfaces. There has not been opportunity, as yet, for the complete analysis of whatever these pigments may consist of; but, in one example, we are informed, the gloss and tint of golden hair, with the true auburn tinge glancing through it, is illustrated to absolute perfection. Still there is a general resemblance between the paintings brought to light in the eighteenth and those unveiled in the latter half of the nineteenth century—only that the further we penetrate the more characteristic do the demonstrations become, whether in fresco, distemper, or encaustic, though it is confidently asserted that from age to age the same processes have with more or less skill been employed. The Neapolitan chemists, in fact, have not scrupled from time to time to seize upon these fragments of painted beauty, and analyze them for the sake of arriving at the secrets of their forefathers. This, indeed, is known to have been done, and is done now, with reference to painting on panels of wood and slabs of ivory, and even with layers of color rasped from the surfaces of pure white marbles, such as were lavishly employed—almost always to be artificially variegated, however—by the fanciful and fastidious decorators of Pompeii. Upon the whole, as this antique city is thrown more and more open to modern light, it proves to be the richest memorial extant of the Grecian genius as represented by an art so different from, and still at the same time so kindred to, sculpture. In most other classic centres, while the form and the purity have survived, the color and the splendor have faded; but here as chamber after chamber, gallery after gallery, is opened, a new beauty of the past appears, freshly vivified by the long excluded light, and, as we are assured, labyrinths of interest remain yet to be explored. The latest formal report was dated 1874—the last belongs to the autumn of 1876.—*Building News.*

AZTEC RUINS IN ARIZONA.

A traveller, writing from the White Mountain Agency, Arizona, describes some ancient ruins less than two miles from the military post up the east branch from the White River. The main buildings are of sandstone, the ledges of which are found in the bluffs about a mile distant. The outlying buildings were no doubt constructed of wood or adobe on stone foundations; but the *débris* of the main building, which covers about two acres of ground to an average height of about six feet, would indicate that they were entirely of stone. The form of the building was nearly square, and set due north and south. Some of the outlying buildings were circular.